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PROVIDING A CHALLENGING PROGRAM IN MATHEMATICS AND SCIENCE FOR PUPILS OF SUPERIOR MENTAL ABILITY*

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It is particularly fitting that we should be discussing the subject of exceptional children at this meeting, for it was in Cleveland that much of the pioneering work was done in this field. I refer to the work of Miss Florence Hungerford and Mrs. Benjamin Bole. Their contributions marked the third distinct period in this particular phase of education. The first two phases, according to Bentley, were the period of flexible promotion extending from 1867 to 1899, and the period of acceleration from 1900 to 1919.

I shall preface my very brief remarks by confessing that I am not by virtue of any special training or experiences qualified to undertake such a discussion. I do, however, have a firm conviction that we are not training our exceptional young people for the positions of leadership which they in the future should be expected to assume.

A macroscopic examination of many of our political leaders reveals that they have risen to positions of leadership without benefit of or through the channels of special schooling for their roles; and in many cases they give no evidence of being intellectually superior. On the other hand, there may be many a potential scientific researcher puttering away at some routine job, merely because he never had the opportunity to develop his talents.

As a nation we can not hope to maintain our industrial and political superiority if we continue to ignore the obvious. Technologically, the United States is supreme; in the field of pure science we leave

* Read at the 51st Annual Convention of the Central Association of Science and Mathematics Teachers, Nov. 24, 1951.

much to be desired. It is in this latter field where we, as teachers of science and mathematics, must put forth our best efforts. We must be able first to recognize unusual ability; and second to motivate dynamically those with that ability to enter the field of science.

It is somewhat alarming to study the statistics relating to enrollment in our optional secondary science courses, specifically chemistry and physics. It is particularly alarming to find so few of our intellectually superior girls enrolling in these courses; this, in spite of the fact that women are in many respects better adapted to scientific research than are men.

Living in an age when survival seems to be mathematically in direct proportion to scientific achievement, we should take stock of our intellectual assets and act accordingly.

We come now to a definition of intellectual superiority. Since we must give some figure as a base, let us use an intelligence quotient of 120–130. Some 6 per cent of our population fall into the lower figure and 1 per cent into the top one. It seems that these individuals, assuming normality in other respects, are capable of exceptional work. It would be a bit unusual to find outstanding contributions in the field of science from those with IQ's of less than 120.

It must not be assumed that the IQ is the sole standard that should be used to segregate exceptional youngsters, but at least it must be the major criterion by means of which they are judged. In any event, there are, we know, exceptional children; and if the base mentioned seems not to be the one most feasible, the experts may determine that in any way that they see fit.

The most important aspect of the discussion is not how they shall be detected and segregated; it is what shall we do with them after they have been recognized. The solution promulgated here is not given with any feeling of finality. There are many factors involved, and much intelligent planning would have to take place before the project were undertaken.

Since we, as social individuals, must of necessity make provision for the care of our indigent, insane, criminal, and so forth, does it not logically follow that we should be willing to set up centers where we may train those whose intellectual potential is such that they would be considered worthy of special training? Let us establish throughout the nation schools that are to be used exclusively for the education of exceptional children.

It would be necessary to set up such schools with great care, for there are many inherent dangers. However, it would seem that the benefits to be derived would be so outstanding that the price would not be too great; and let it be understood that although these schools would greatly benefit the students, the ultimate benefit would be to

the nation. These schools should be state-supported, and the pupils should be able to attend without cost, or at a cost not prohibitive to those coming from even the poorest families.

The faculties of these schools should be carefully chosen, and they should be very specially trained. Great care would have to be given to social behavior, because herein would lie one of the potential dangers. The curriculum would have to be broad, and thoroughly challenging. Equipment would have to be superior. Education should continue through high school, and then by special arrangement these youngsters could continue on to college in specially arranged-for courses, possibly in some cases on a graduate level. Since these schools by their very nature would have to be boarding schools, it would be necessary to overcome family resistance to the pupils' being away from home at such an early age. This, however, is not a serious objection.

Briefly, this is the outline of a long range program which would require years of study and possibly the establishment of several experimental schools.

For the present, much can be done in the ordinary classrooms. When possible, exceptional pupils should be permitted to proceed at their own pace. This in essence was the Winnetka system, successfully used in many schools.

When other means are not available, a word here and there, a dynamic interest in the youngsters' future, expressed in many ways, mature and intimate discussions on national or local problems all help immeasurably to stimulate and maintain interest. When possible, exceptional students can be given additional responsibility. The latter should be of such a nature that it presents an intellectual challenge, rather than the type of responsibility that simply relieves the teacher of unpleasant routine work. It is well to keep on hand a list of such projects and the equipment needed to carry them out. Such equipment should be of the type that is not ordinarily available to the average student.

There exists a potential danger in the handling of superior children. If not dealt with properly, they may become intellectual snobs. In some instances the ego may become so inflated that their future education is seriously jeopardized. Watch your exceptional pupils to see that such things do not occur. If such signs appear, take immediate steps to correct the situation.

Now to summarize:

A current need exists for trained scientists, particularly those who can carry on pure scientific research.

Many of our exceptional pupils need training which our present system is ill-equipped to give.

State-supported schools for exceptional children would help to overcome our present inadequacies.

We can help to some extent by giving encouragement, more responsibility, and better guidance to those now in our classes.

Finally, we must watch for the intellectual snags which are ever-present dangers to exceptional children.

In conclusion it must be said that much is already being done. The Science Talent Search, scholarships to various already existing private schools, and many local projects are helping; but far too many of our good students are forced to attend classes with intellectually inferior and in some cases intellectually subnormal children.

There bored, unchallenged, and uninspired by teachers attempting the impossible, they learn bad intellectual habits. Thus they are lost to science, the nation, and the world. Cannot we at least give them the thought, effort, and financial backing that we give their less fortunate brethren?

NUCLEAR ENERGY CONFERENCE AT MICHIGAN STATE COLLEGE

May 20 and 21, 1952

Tuesday

8:30– 9:30.	Registration
9:30– 9:45.	General Announcements and Introductions
9:45–10:00.	Address of Welcome
10:00–10:30.	Basic Nuclear Concepts
10:30–11:30.	Reactor Fundamentals and the Nuclear Power Plant
11:30–11:45.	Movie on Basic Nuclear Concepts
1:15– 2:15.	Present Status of Reactor Development
2:15– 2:30.	Recess
2:30– 3:15.	Heat Transfer and Fluid Flow Problems (Part I)
3:15– 4:00.	Reactor Materials (Part I)
4:00– 4:10.	Recess
4:10– 4:30.	Sources of Engineering Information
4:30– 5:00.	Questions from the Floor
7:30– 9:00.	History and Implications of Nuclear Energy (open to general public) (Possibly a movie either preceding or following the above talk for 15 or 20 minutes)

Wednesday

9:00– 9:45.	Heat Transfer and Fluid Flow Problems (Part II)
9:45–10:15.	Materials for Reactors (Part II)
10:15–10:30.	Recess
10:30–11:00.	Economic Aspects of Nuclear Power
11:00–11:30.	Questions from the Floor
1:15– 2:00.	Implications in the Chemical, Food, and Drug Industries
2:00– 2:45.	Implications in Manufacturing Industries
2:45– 3:00.	Recess
3:00– 3:30.	Radioactivity, Shielding of Personnel, Waste Disposal
3:30– 4:00.	Nuclear Research Machinery—Accelerators
4:00– 4:30.	Nuclear Training for Practicing Engineers
4:30– 5:00.	Questions from the floor

HELPING CHILDREN DISCOVER ARITHMETIC

CHESTER A. McCORMICK*
Wayne University, Detroit, Mich.

For some time there has been a growing emphasis on letting children, working under the guidance of the teacher, "discover" arithmetic concepts and processes for themselves. The teacher, and his way of working with children, plays an important part in determining the success of any program of teaching emphasizing the discovery of meanings and understandings.

While planning to guide children through any new learning experience in a meaningful way it is quite necessary for the teacher to ask herself five questions. These are:

1. What educational purpose or purposes am I seeking to attain?
2. Why am I selecting these educational purposes?
3. What educational experiences can I provide for the children in order to attain these objectives?
4. How should these learning experiences be organized to produce most satisfactory results?
5. How can I be sure that I am attaining the desired objectives effectively and economically in terms of time and energy expended?

More and more teachers are beginning to realize that education is a process of changing the organization of behavior patterns of boys and girls in such a way that these patterns will persist. They are also beginning to realize that this process of change and persistence is not due to maturation alone.

In battle, soldiers are given a target to shoot at or a section of a hill or valley to capture. The practical thing, therefore, since their lives depend upon the pre-planning, is to select the necessary weapons, the maps and ammunition they will need and the route of advance. Careful planning means success. Poor planning means disaster or loss in one form or another. This same group of soldiers is evaluated in terms of success or failure in carrying out the mission assigned.

In education it is even more necessary to select our objectives with care and see to it that we attain them with the least possible delay. The objectives we select become the criteria for:

1. The selection of teaching and learning materials.
2. Outlining the content to be learned.
3. Development of instructional techniques and instructional procedures.
4. Preparation of a variety of methods and instruments to be used in evaluating progress toward desired ends.

Few teachers will deny that it is as important to know *how* to teach as it is to know *what* to teach. The success of an enriched program in

* This paper was presented to the Elementary School Group of the Central Association of Science and Mathematics Teachers, Cleveland, Ohio, November 24, 1951.

arithmetic emphasizing the ability to do quantitative thinking and an understanding of arithmetic as a closely knit system of ideas, principles, and processes, depends in the final analysis on classroom method. For this reason it is especially important that teachers be familiar with at least seven general principles of method which underlie the meaningful teaching of arithmetic.

The first of these seven general principles* maintains that "Children must be given an opportunity to learn through experience." Comparatively speaking, just as soldiers are introduced to close overhead machine gun fire before attempting to take an enemy fortification, so must children come to see arithmetic as a very real aspect of their environment and of their experience. If children are to learn that numbers contribute to accuracy and efficiency in expressing ideas, then they must have experiences which demonstrate this accuracy and efficiency. If children are to understand the value of learning to use addition and subtraction, then they must have opportunities to see the applications of these processes in life outside the school. The child learns arithmetic only as he builds up meanings for himself and thus he learns arithmetic only as he builds up meanings that are consistent with the number system which society through its school impresses upon him.

The second general principle grows out of the number system itself. Stated briefly, "Arithmetic should be taught in such a way that generalizations and number relationships are stressed." Arithmetic is a system of abstract ideas. As such it contains relationships and connections which, when mastered, enable children to progress more rapidly in their learning.

Understanding of arithmetical facts and processes is gained slowly over an extended period of time. Attainment of understanding requires a large amount of meaningful experience. The meanings in the number system depend upon one another. The simple meanings must be gained first and the more complicated ones can grow from these much as the complex structures in our large cities are all firmly based upon the good solid surface of the earth or upon the rock formations beneath its surface. Instruction in arithmetic must be so organized that experiences of the learner will be constantly related and interrelated with ever larger and larger patterns. For example, as the child learns to count and to write numbers he develops simple understandings of the tens system and the role of zero. As he advances through the grades these understandings are enlarged and extended in helping him understand regrouping, the placement of partial products in

* Junge, C. W., *A Foundational Program of Arithmetic from a Mathematical Point of View.* (Unpublished Dissertation) University of Iowa.

multiplication and division and the extension of our number system into decimal and percentage problems.

Generalized ideas with which to interpret and control new situations are the means of continuous adjustments, or of the utilization of previous experience under different conditions. To acquire these generalized meanings it is necessary to learn them in the content of the closely integrated, logical system in which they belong.

The third general principle of method indicates that "procedures employed in teaching should be such that learning will be carried on in the spirit of inquiry; and opportunities will be provided for the discovery of number relationships by the child." Experiences of observation, manipulation and recording will culminate with the making of deductions or the discovery of generalizations which represent insight into the number system.

It must be understood, of course, that children will make their discoveries under the guidance of the teacher. The teacher will provide new problem situations in familiar settings in order to stimulate the thinking of the children and to provide opportunities for him to comprehend the old in terms of the new.

A fourth general principle of methods stresses that "meaning is given to arithmetical facts and processes through the use of concrete materials." It is important that the child's first learning experiences with any fact or process be as concrete as possible. He should see, touch and handle as many as possible of the objects whose number relations he is considering. Later on, when concrete number concepts are clearly established, the experiences can become more abstract. However, the transition from the concrete to the abstract must not be too abrupt and even after the children have been working with abstract symbols, the teacher must be careful to continue concrete associations in order to insure understanding.

A fifth general principle of method emphasizes that "new facts and processes in arithmetic should be introduced in comprehensible problem situations." Problem situations used in introducing new concepts and processes provide the "felt need" necessary if learning is to be carried on in the spirit of discovery. It is important that the problems used in this way will be real or the type that could be real. By far the best problems to use are those which arise naturally out of the child's experience and which demand solution. Familiar problem situations offer the greatest possibilities for the child to gain understanding of the new facts or processes.

The sixth general principle provides for increased efficiency of time and energy, namely, "there is a place for drill or practice but it must come after understanding." Since a relatively long time has been

recommended for the children to learn facts and processes, it follows that practice will come a long time after the introduction of these facts and processes. The children must have many varied experiences with each new idea, fact or process before practice begins. When practice is started, it should be a meaningful type of practice, one which stresses thinking, the seeing of relationships, and the strengthening of associations. Mere mechanical, rote drill is not adequate. Drill, per se, yields no insight into number, cannot make numbers meaningful, and if given prematurely can be decidedly harmful. Children must see the need for practice and they should have a part in planning it.

Finally, "arithmetic experiences should be accompanied by feelings of satisfaction and competence." None of us enjoy failure. Much less do we enjoy repeated failure. Therefore, the teaching procedures used should be of such a nature that the child will approach problem situations with a feeling of confidence and without fear. For this reason it is of the utmost importance that the children be provided with a systematic method of attack on problem situations. It is likewise important that children be given opportunities to appraise their own work, to note their own deficiencies, and to work out systematic plans for improvement.

During the summer of 1951 a new film based upon these seven general principles was released by the Audio-Visual Materials Consultation Bureau, College of Education, Wayne University, Detroit, Michigan. The title of the new film is "Helping Children Discover Arithmetic." It pictures the progress of a third grade class from the introduction of an arithmetic process new to them, borrowing or regrouping in subtraction, to a point where the pupils understand and are able to work problems relating to the process. In illustrating in detail the method used, the film pictures four consecutive daily arithmetic periods.

The class used can be termed an "average" one. It consisted of thirty-one pupils. Because all photography was taken in the group's regular classroom, however, there was no opportunity to show the entire group at one time. This fact is mentioned because teachers viewing the film might otherwise feel that the method is applicable only in classes of limited size.

The film attempts to be representative in all other aspects as well. The classroom is one that might be found in the large majority of our schools. None of the instructional materials used is beyond reach of any teacher. It cannot be argued, therefore, that the method pictured is dependent upon special equipment or conditions.

Although the film, "Helping Children Discover Arithmetic," deals with the process of "regrouping" or "borrowing" in subtraction, the method illustrated is applicable to other arithmetical concepts and

processes. In fact, the method employed can be used in other curriculum areas as well. It is simply the application of the scientific method to the teaching of arithmetic.

The "discovery" method, as presented in the film, should in no way be considered a set procedure. The principles are constant but the manner of presenting new problems, the type of materials used, and the ways of providing drill situations will vary with individual teachers, and with a single teacher in presenting different concepts.

The author firmly believes that skill in computation is not the only or even the most important outcome of learning in arithmetic. He does believe, however, that growth in the ability to think quantitatively is a primary objective. Children must become acquainted with and use numbers extensively, both as oral and written records, to describe what is done about quantitative situations. Successful and efficient extension of number usage from the crude methods of early childhood to those of the competent adult can be facilitated by increased insight into the interrelationship of the number system and by utilizing the other six guiding principles of method as outlined above.

HARVARD SUMMER SCHOOL

President James B. Conant will offer a course for high school science teachers in the Harvard Summer School of 1952.

The course, "The Methods of Science," will be the core of a special program in science education planned for this summer's program.

A number of scholarships, varying in size from tuition cost to full travel and living allowances, will be offered to assist qualified teachers to join in the program.

The course will follow the "case history" method of teaching how scientists work. President Conant introduced this method a few years ago for teaching science to freshmen and sophomores in Harvard's General Education program. The development of major scientific concepts will be illustrated by the study of the actual work of scientists.

The course will be concerned with the relation in high school science teaching between factual information and knowledge of the methods of science.

President Conant will be assisted in teaching the course by Associate Professor Fletcher Watson of Harvard and Dr. Paul F. Brandwein, Head of the Science Department, Forest Hills, N. Y. High School, and Lecturer at Teachers' College, Columbia University.

Dr. Brandwein also will give a course in "Methods, Procedures and Materials of Science Teaching," centering on the science teacher's problems in making science interesting and significant to the pupil. Teaching methods, procedures, laboratory work and documentation will be analyzed.

Professor Watson will teach a course for elementary teachers on "Science in the Elementary School," which will discuss selection of topics, unit planning, and teaching materials.

Other courses of interest to science teachers will be offered by the 1952 Harvard Summer School in the fields of astronomy, botany, zoology, genetics, chemistry, mathematics, physics, and the philosophy of science.

TEACHING SCIENCE THROUGH TELEVISION

JOSEPHINE F. BORDONARO
Theodore Roosevelt Junior High School, Syracuse 5, New York

Once a week, the Syracuse public schools present a fifteen minute SCIENCE television show. Two students and their teacher generally appear at each occasion.

The first program dealt with carbon dioxide and consisted of several experiments that could easily be duplicated at home. For example, Joan made carbon dioxide with vinegar and baking soda and then carefully poured the gas into a glass of limewater. John folded a piece of aluminum foil about twelve inches long and poured the gas down this trough towards a candle. They ended their program with some "dancing mothballs" explaining that the rising and falling was due to presence or absence of CO_2 on the surface of mothballs. This experiment was televized at 4:45 P.M. and I have been assured that there were "dancing mothballs" on several supper tables that same evening.

When asked by my supervisor to prepare a television script on "Building a Weather Station," I accepted readily. Two students volunteered to work before and after school on the project. Patricia had just read Schneider's book *Everyday Weather and How It Works* and began making some of the weather instruments described. Her classmates aided with contributions of cardboard milk cartons and other materials. The boys in woodshop helped her nail the wind vane and anemometer to the top of a hall tree. On a shelf, she placed three milk cartons that had been turned into a barometer, hygrometer and rain gauge. Meanwhile, Robert was busy bending a glass tube to use for a model of a cape-cod barometer. He was also learning that weather instruments are fragile. Once he dropped a hygrometer and broke its water tube and again, during the last rehearsal when it was too late to be replaced, a little "swan barometer" slipped from his fingers. The final mishap was revealed when the weather instruments were unpacked at the radio station and it was discovered that Robert had forgotten an aluminum wind vane of which he was very proud. Nonetheless, the presentation given by these two fourteen year old students was highly rewarding to both parents and teachers. This telecast with its predecessors demonstrates that teaching science through television can be effective.

What we need in this country is not more dollars but dollars that buy more.—LOUIS BROMFIELD.

HISTORICALLY SPEAKING

Mrs. James T. Gray
La Porte High School, La Porte, Texas

Historically Speaking—a playlet with numbers presenting historical data on the development of the zero, weights, measurements, and time—is designed to appeal to children in the upper intermediate and junior high grades. As written, the playlet would require about thirty minutes playing time; but it is so constructed that a classroom teacher could easily divide it into two or even four short presentations.

Characters

Mr. History—the narrator
The Numbers—1, 2, 3, 4, 5, 6, 7, 8, 9, and 0
Mr. Ruler
Two Cavemen

Costumes and Setting

Matters of costumes, setting, and scenery should be left to the ingenuity of the pupils, with the teacher's guidance; all, however, should be kept simple since attention should be focused on content rather than on props. A backdrop—if the presentation is to be on a stage—or a blackboard—if it is to be in the schoolroom—on which drawings of footprints gradually fade off into a 12 inch ruler, a graphic picture of the numbers 1, 2, 3, showing how they have developed into the characters we use today from being hurriedly written — = ≡ 1 2 3, drawings of the hand—perhaps measuring the height of a horse—etc. would blend effectively into the content material.

For Act II, the following props are suggested: a large calendar in use today and one of the proposed world calendars, if such is available; a stick; a bucket from which water drips slowly; a piece of rope knotted at two and one-half to three inch intervals; a large candle marked off into black and white sections; a sandglass; and, if possible, a pendulum clock opened at the back to expose the wheels, pinions, springs, etc.

(*Children representing numbers One through Nine skip onto the stage.*)

Chorus.

Oh, we're the jolly digits;
We run from One through Nine.
If you have any problems,
We'll solve them for you fine.

(*A noise is heard offstage; in comes Zero*).

ZERO (*strutting*). So, you think you don't need me! I may be called Zero or even "Nothing" but I'm very important just the same.

CHORUS (*chanting*). *Important* he says! He doesn't *even* count.

ZERO. But I do; and I can prove it.

CHORUS. Prove it then.

ZERO. Very well. I can do it in a very simple example. 8 plus 2 equals.

(*The numbers mill about trying to form an answer but are unable to do so.*)

ZERO (*finally closes in by one and solves the example*). You see, I have a place in an easy little example like that. Now, try this problem: John and Mary went in together and bought their mother a Christmas present for which they paid $8.16. How much was each child's share?

(*The numbers form the problem and attempt to solve it. They stop with 48.*)

ZERO (*jeering*). 48 what? So 48 times 2 is $8.16? That's news!

CHORUS (*apologetically*). Well, we do need a dollar sign and a decimal.

ZERO. Yes, and you need more than that. You need me. (*Moves into his place in the problem.*) Now, will you stop trying to run away and leave me? Haven't I proved I have a *place* with you?

CHORUS. Oh, we're beginning to see. That's why teacher calls you a "place holder." Come join our jolly group.

ZERO (*triumphantly*). Yes, and I'm more than a place holder. Sometimes I'm a real number. (*Holds up thermometer.*) You see, on this thermometer I'm a number.

ONE. But, really, we are very important. We're the base of ten, the backbone of our number system.

TWO. I challenge anybody to write a number and not use one or more of us!

THREE (*swelling with pride*). I guess we're about the most importantest folks in the world.

FOUR. Yes, and always have been, no doubt.

(*Old Man History, enters. This character will be the narrator and not required to memorize all of his lines.*)

HISTORY. Good day, children. I hear that you are *very* important. Well, perhaps now, but like so many other folks, you aren't wise enough to realize that you weren't just born that way. There's a little matter called history that you should learn something about.

CHORUS. Old history! Who likes old history?

HISTORY (*patiently*). Please take your seats while I turn back the pages of time. (*Indicates places for them to sit.*) You'll soon see how you grew. Many and many years ago—almost more years than you can imagine—there were men here on earth. Now, these men lived very simply; they didn't have money as we do; they didn't

trade as we do today; but they did do some trading and they did have ways to show what we call "numbering." Look closely, now, and I'll show you.

(*There is a rustling noise at the side of the stage and two pupils dressed caveman style enter. They carry sticks.*)

FIRST C. Want horses? How many?

SECOND C. (*holds up four fingers*).

CHORUS. Kid stuff. Babies can do that.

HISTORY. S-sh! Sure, this period was the infancy stage of man. But they had their fingers or "digits," which we call you sometimes, with them at all times and could use them for counting as long as what they were counting didn't go above ten. But, look!

FIRST C. Want sheep? How many?

SECOND C. (*begins laying out sticks; lays out nine; lays up one big stick and removes nine small sticks. Again lays out nine, etc. until he has indicated forty.*)

TWO. What's he doing? He lays out nine little sticks, then lays out one big one and picks up the nine little sticks, then he does the whole thing over again.

HISTORY. You see, these people didn't have you, One, Two, Three, Four, Five, Six, Seven, Eight, Nine and Zero, so they had to make a real picture to show counting. Some of the ancient people drew marks on the ground; the Indians in our own country carried bags of rock to use in counting. (*Cavemen troop offstage.*)

CHORUS. Well, I never!

ONE. But, what did they do when they wanted to write it down so they wouldn't forget?

HISTORY. The time did come when man wanted to keep numbers in mind or make notation. To do this, some of the ancient people used a dust board upon which marks were recorded. This was known as the abacus from the Greek word *abax* or dust. This primitive instrument developed into a frame, like this (*holds up an abacus*). The people of ancient Egypt, Babylonia, Greece and Rome used this instrument.

ZERO. Children play with things like that; that's kids' stuff.

HISTORY. Perhaps. But up to this time, you had not been born, Zero. (*History demonstrates how the abacus is used.*)

ZERO. Mr. History, how *did* I ever get here?

HISTORY. In the twelfth century the western world adopted the Hindu-Arabic numerals one through nine; but as long as the abacus was used, you were still not needed. (*History demonstrates how 2004 would be recorded on the abacus, calling attention to the empty columns.*) Finally, Zero, the Hindus realized the need for a sign to fill in these empty columns and then you were born.

ZERO. Hooray for the Hindus!

HISTORY. Yes, hooray for the Hindus. They gave us the best number system known today; and when they gave us you, Zero, they made it possible for us to do calculations, that is add, multiply, subtract and divide, as we do today.

ONE. All of this is interesting, but can't you tell us something besides things about Zero. He's getting a big head.

HISTORY. Would you like to know something about the history of weights and measure?

TWO. Sure. Many times we associate with names like feet, inches, etc., but I had never wondered about them.

HISTORY. From what I have told you already, would you like to guess how the first measurements were made?

(*The numbers scratch their heads.*)

ONE (*brightening*). Now, there's the foot; and I've heard of horses' being so many hands high. (*He grows excited.*) That's it. Just as people used their fingers for counting long, long ago, they used parts of their bodies to measure.

HISTORY. You're absolutely right! Now, let's see how the parts of the body were used to measure.

(*A child enters dressed as a twelve inch ruler.*)

CHORUS. We know what that is. It's a foot and it's twelve inches long.

HISTORY. You're right; but listen.

RULER. I am a foot or twelve inches and you will find me so in all English-speaking countries, but in other countries I may be anywhere from eleven to fourteen inches. In the long, long ago men measured me by their own feet; but, of course, every man's foot is not the same size; but many, many years passed before I was standardized.

CHORUS. What does he mean by "standardized"?

HISTORY. Sh-sh. I'll tell you later.

RULER. You see, I'm marked off into twelve equal parts called inches. Inches comes from the word "unciae" meaning twelfth part. But can you imagine what part of the body was used at first to measure this part of me?

ZERO. Maybe it was the width of the great toe?

RULER. Very good try. But, no. It was the width of a man's thumb. Maybe the thumb was used instead of the toe because a man didn't like taking off his sandals.

TWO. What about the measure *hand* we hear used today.

RULER. The hand is four inches or the width of a good-sized man's hand.

THREE. I have even heard of the span. What is a span?

ZERO. I once heard of a span of mules.

THREE. Don't be funny, Zero. You're the only one of those around here.

RULER (*ignoring the repartee*). A span once upon a time was the distance from the end of the thumb to the end of the little finger when the hand was stretched out, or, as later standardized, nine inches.

FOUR. Gee, you really are smart, Mr. Ruler. I'll bet you could tell us lots about some more of your kinfolk. What about the yard? I hear it takes three of you to make a yard.

RULER. You are right. Of course, there are many stories told about the yard, but the one I like best is this. In the twelfth century Henry I of England fixed the yard as the distance between his nose and the thumb of his outstretched arm. Did you ever see a woman measure cloth in this way? But, eventually, of course, it was standardized as thirty-six inches.

FIVE. I help to tell how many yards there are in one measure—the rod. Could you tell us about it?

RULER. Yes, the rods were among the earliest standards of length. I suppose that was because rods were used to measure the acre; and, as you know, the acre is a measurement of land. Even in very early days men were proud to own so many acres of land.

SIX. Yes, I have heard that land is one of man's safest investments.

RULER. That's true. During the middle ages, the length of a rod was determined by lining up sixteen men outside of church on Sunday morning and measuring the combined length of all their feet. See, that was using the body again as units of measure.

EIGHT. But, some men's feet are long and some short.

HISTORY. True. That is why the rod was finally set by Henry VIII of England at five and one-half yards or sixteen and one-half feet; and an acre was decreed by him to be the area of a piece of land forty measuring rods long by four rods broad.

SEVEN. It seems to me that I once heard a man measured off an acre by using the rod he used to goad his oxen.

HISTORY. Yes, that is another story that is told about the rod and the acre. You may believe either or both.

NINE. I know one that I'll bet you can't say came from the body. The mile—anybody knows that many men couldn't have been lined up and measured.

RULER. But, you have guessed wrong, Nine. The mile comes down to us from the Romans. Originally, it was five thousand passus or paces of a Roman soldier. The pace was a Roman measure five feet long or the distance from the place where one foot left the ground to the place where it was put down a second time. So, you see, the human body was used again. In Roman times the mile was five

thousand feet, but in 1500 it was changed to five thousand two hundred eighty feet.

FIVE. But, why did they change it? Five thousand looks much simpler than five thousand two hundred eighty.

HISTORY. It was done to help the surveyors. The furlong, which was the commonest land measure in England at the time, could be divided into a mile eight times when there were five thousand two hundred eighty feet in the mile.

THREE. How confusing! What is a furlong?

HISTORY. Well, the furlong was something farmers had near them at all times, too; though, it was not a part of the body. It was the length of a furrow in an ordinary field or one-eighth of a mile.

TWO. Oh, dear, *a furrow*. But, what is a furrow?

HISTORY. Excuse me; I forgot that many of you have never lived on a farm; but I am sure all of you have driven in the country. How many of you have?

(*The numbers wave their hands eagerly.*)

HISTORY (*continues*). I am sure most of you have driven along the highway and looked down the long rows of freshly plowed ground. (*The numbers nod enthusiastically.*) Well, those rows are the same as furrows.

TWO. And, the furrow used to be one-eighth of a mile. I'll bet our furrows are longer than that.

HISTORY. In many cases, yes. But can you imagine why.

THREE. In those days men didn't have tractors; they had to walk and drive oxen, but I'll bet they got plenty tired plowing a furrow.

NINE. All of this has been very interesting, Mr. History, but you also promised to tell us about weights as well as measures.

HISTORY. Oh, yes, I did! Measuring came before weighing. You will not be surprised to know, I'm sure, that the very first way of counting weight was what a man could carry or hold.

ZERO. Wasn't that a bit stupid? Anyone knows a man could carry more hay than rocks.

HISTORY. It may appear stupid to you, Zero. But just the same, it was a long, long time before man developed the idea of balancing. Just a minute; I'll show you the sort of scale early man used. (*Children enter carrying a stick hanging by a cord tied around the middle; on each end is tied an object. This makes a crude scale.*) As the ancient countries grew through trade and commerce, better means of weighing were needed; and as early as 3000 B.C. the Greeks, Romans, Babylonians, and Egyptians had standardized weights and measures.

ONE. There's that word again, *standardized*. What is a standard, Mr. History?

HISTORY. I did promise to tell you, didn't I? I'll explain it this way. Earlier, we were talking about the yard's being the distance from a man's nose to the thumb of his outstretched arm. You know, of course, that distance would not be the same on every man. Therefore, one day a king said, "Hear ye! hear ye! a yard shall be thirty-six inches." Now, this yard is known as a unit of measure; and it is thirty-six inches because the law says so. But the standard which you are so interested in is an actual physical reproduction of this thirty-six unit. The standard yard is a bronze bar with fine lines engraved exactly thirty-six inches apart on gold studs set in the bar. So, when a yard is standardized, it is compared with this bronze bar. Other things are standardized in similar ways.

FOUR. That is interesting. If I were to order some material, I *would* want three units thirty-six inches long and not three of different lengths, wouldn't I?

HISTORY. Of course, that is why standards were necessary in busy, growing civilizations. These things grew out of the needs of the people. But, did you know that on some of the South Sea Islands people live so simply, merely trading things they have for the things they want, that they have not passed beyond the stage of this early, early man we have been talking about?

ZERO. Gee, do you mean that maybe they don't even know about us?

HISTORY. I shouldn't be surprised if they've never *even* heard of you, Zero. But, we should talk more about weights. Did anyone ever ask you which would weigh more, a pound of feathers or a pound of lead?

THREE. Yes, and I said lead!

HISTORY. And, why did you say lead, Three?

THREE. Well, just look how many more feathers it takes!

HISTORY. That's true, but you are confusing mass and weight. You see, mass is the actual quantity of the matter or material in the object and the weight is the strength of the pull of gravity.

FIVE. Gravity. Will you please tell us a little about gravity?

HISTORY. There is a force in the middle of the earth that pulls everything toward it. That force is called gravity. If any object is held above the ground and turned loose, it is pulled to the ground by this force. So, you see, what a thing weighs is determined by this pull called gravity, not by the quantity of the matter. But, we must hurry along and learn some more about weights. (*History claps his hands. Child appears representing the Grain.*)

GRAIN. I am the smallest unit of measuring. I was standardized thousands of years ago. Originally, I was a grain of wheat taken from the middle of the wheatear. In some countries I was a grain of barley. You will also find that I am used by your druggist to

weigh up your dosages of medicine.

DRAM. (*Enters and stands by Grain*). I am a dram. Originally in Greece, I was "a handful." So you see, I am more than a grain. In fact, I am 27.3437 times as much as a grain.

OUNCE (*enters and stands by Dram*). My name comes from *unciae* the same as does Inch, and I mean a twelfth part. You see, I came from Rome where a pound is only twleve ounces. It takes sixteen drams to make one of me.

POUND (*takes place in line*). I am the pound. Sometimes I am twelve ounces, but usually in America I am sixteen ounces. I come from the Latin pondo.

TON (*takes place in line*). Now, I am a heavy fellow. I weigh 2000 pounds if I am short or 2240 pounds if I am long. I am usually long in England but short in the United States and Canada.

HISTORY. These weights who have introduced themselves to you are what we call avoirdupois. This is an old French word meaning "goods of weight" and this system of weights is used in all English speaking countries; and it is used to weigh everything except drugs, metals, and precious stones.

(*The avoirdupois weights leave.*)

CHORUS. Thank you, Mr. History, for this interesting information. Will you come and tell us more some other time.

HISTORY. Yes, I will. When you mention *time*, it not only reminds me that it is time for me to go, but brings to mind all the interesting gadgets used in time past to tell the time of day or night. But, I'll have to return later to tell you that.

CHORUS. Good-bye, Mr. History.

ACT II

(*The numbers are speaking together when History enters. They go to meet him.*)

ONE. We were hoping you would come as you promised to tell us about the measurements of time.

HISTORY. I feel pleased. As I recall on my last visit you did not welcome me so warmly.

TWO. Oh, but *you* taught us a thing or two.

THREE. Indeed, you did!

HISTORY. Well, let us get down to work for the sand of time is running out.

FOUR. What a queer way to say that time is passing. Why do you say it this way?

HISTORY. When I tell you about the different ways of measuring time in the clockless ages, you'll understand. But, first let's see how many ways you can think of that we use to measure time.

Five. Well, just today I heard a little boy say that he is ten years old; so I am sure a year must be one measure of time.

History. You are right. Who can think of another?

Six. I think I have heard it said that a year is made up of twelve months.

History. Right again. Who knows another way?

Seven. A month is divided into weeks.

Eight. And a week into days.

History. Fine. Let's stop here just a minute to see what it is in man's environment, or in the world in which he lives, that caused him to settle on these divisions of time.

Nine. Well, there's the world itself.

History. Yes, and what else?

Nine. And the sun and the moon and the stars.

History. You're right, Nine. Thousands of years ago men were aware that day always follows night, that the seasons—spring, summer, fall and winter—always follow each other in order, that the moon goes through a certain cycle, and that the sun seemed to follow a certain path. As early as four thousand years ago the Chaldean astronomers—or men who study the heavens—marked the path of the sun through the heavens and arrived at the idea of twelve months to the year. Then they divided the lunar, or moon, months into days and days into hours.

Eight. Well, all of these measures of time except the hours are found on calendars, aren't they? Do you mean to say we've had the same calendar we use now for 4000 years?

History. We have had a calendar all of this time, but there have been many changes made in it. For instance, the month of August which was named for Caesar's nephew Augustus at one time had only thirty days. Some of his admirers felt this not to be complimentary to him since the month of July, named for Julius Caesar, his illustrious uncle, had thirty-one days, so they added a day to August and stole another from the shortest month of the year, February.

Seven. What are these things called leap year? Why do we have them?

History. In order to keep up with the solar system, an extra day has to be added to February every four years and that is called leap year. During the time of Pope Gregory XIII, in 1582, it was found that the calendar was getting away from the exact year as figured by the astronomers. In fact, it was ten days beyond the solar year. The Pope decided to drop ten days and in addition to drop three leap years every 400 years. The year 1600 was a leap year, but 1700, 1800 and 1900 were not but the year 2000 will be.

ONE. Now, some folks have a hard time keeping up with their birthdays. Since the Pope and the Caesars changed the calendar, why doesn't the President or somebody make one so a person's birthday can be on the same day every year?

HISTORY. You are closer to fact than you think, One, because just such a calendar, called the World Calendar, is being worked on at this time; and, who knows, someday we may have a new calendar that we can all commit to memory!

TWO. But, won't the calendar makers go mad?

HISTORY. They'll just turn to something else. Progress cuts some people down but raises others up. That's life.

TWO. History, did you not promise to tell us something about the different timepieces used down through the ages?

HISTORY. Yes, but I'd like to show you some of the earliest kinds used. Do you see this stick? (*Numbers nod.*) One of the very earliest means of telling time was by fixing a stick upright in the ground and taking note of the spot reached by the shadow. (*Demonstrates.*) Of course, the shadows grew shorter before noon and then they gradually lengthened again after noon.

ONE. But, what if the sun didn't shine?

HISTORY. That was one of the troubles with this means of telling time that caused men to hunt something better. Another means of telling time which the Chaldeans discovered was the sundial. Many of you have seen these in parks. The main trouble with these, too, is that they do not show time on a rainy day, and they stop working at sundown. But it was the best man had for a long time, and they were found in ancient Egypt, Jerusalem, Rome, and Greece.

TWO. What did people turn to next, Mr. History?

HISTORY. Well, water is something in the environment that man cannot do without and always has near him. Eventually, someone experimented by making a small hole in the bottom of a bucket and then filling the bucket with water. The water leaked slowly but steadily out until what was put in at breakfast time was leaked out about supper time, thus measuring a day. Of course, in time these water clocks were made more and more elaborate. These clocks were popular in Greece and Rome.

EIGHT. But water freezes and evaporates; so that means of telling time couldn't be too exact, could it?

HISTORY. No, that was one thing against this type of time telling machine. Do you see this knotted rope? This was the sort of a timepiece the Chinese used. They set fire to this string and it smoldered and burned, marking off the hours.

FIVE. That could tell time at night, couldn't it?

ONE. Sure; but it had to be kept out of the wind.

HISTORY. You are right. I am told that this method of telling time is still used in parts of Korea. Fire was used to mark time on another ancient time-teller. At night, men used to mark a candle off in black and white sections that would burn in a given time. The hours were estimated from this, too; but, of course, the candles had to be kept out of the wind. Lamps later were used, note being taken of the oil being burned.

FOUR. What about the "sands of time," History?

HISTORY. For thousands of years the sandglass or hourglass was the most common timekeepers in general use outside the wealthy homes. The sandglass consisted of two glass globes, one above the other, separated by a very small hole which allowed sand to trickle from the top globe into the bottom globe. We find these on sale today for the careful housewife who wishes to time her three minute eggs.

SIX. Oh, I've seen those things. They're clever.

HISTORY. It is not known who invented the first real clock as we know it with its wheels, pinions, springs, pendulum etc. But it is recorded that in 1657 Huygens, a distinguished Dutchman, designed and either made or had made the first pendulum clock. Since that time, slow but steady progress has been made in time telling machines.

ONE. Well, we've certainly come a long way, haven't we? Even small children can have their Mickey Mouse and Donald Duck watches now, can't they?

HISTORY. We really have, but it is time for me to leave you again.

CHORUS. Good-bye, Mr. History, come again soon.

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Spitzer, Herbert F., *The Teaching of Arithmetic*, Houghton Mifflin Company, N. Y., 1948.

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Stories of Science, *The New Human Interest Library*, Volume 2, The Midland Press, Chicago, 1936.

Flower-pot covers now can dress up the clay flower pots holding the housewife's indoor plants. Mace of Vinylite plastic sheeting, the covers resist moisture, chemical action from dissolved plant foods and abrasion by gritty soil particles.

Scrub brushes with long handles have been developed which will outwear five ordinary brushes, according to the manufacturer. The brushes employ stiff bristles made of Bakelite styrene plastic.

MAKE THEM WANT TO LEARN*

THE SCIENCE MAGAZINE IN THE CLASSROOM

HARTLEY E. HOWE
Senior Editor, Popular Science Monthly

Needless to say it I am very flattered to be invited to take part in this panel. The fundamental problems of a teacher and an editor are very similar—yet their approaches are sufficiently different so that each can learn a good deal from the other. And we owe a good deal to each other too. My own magazine in particular—*Popular Science*, now a few weeks short of 80 years old—owes its birth to the public demand, created by wide public education, for a periodical that would tell the average literate man about the new vistas that Darwin, and Pasteur, and their fellows were opening up. And we know today that our faithful readers of the next three decades are coming out of the science classrooms of the schools of America.

But if we depend on you for our readers, I'm delighted to know that we return the favor by helping you with your students. Actually, I imagine that so far as the actual use of magazines in the classroom, you know a great deal more about it than I do. What I will do is to point out where our aims agree and where they differ, explain some of the techniques we use that might offer some suggestions to teachers, and point out something of the benefits that the use of science magazines can bring to science teaching.

Obviously, of course, we share a common objective. We both are eager to make people—readers or students—*want* to learn. It's your objective because you know your teaching will be twice as effective if you can enlist the interest and enthusiasm of your students. Our motive is less idealistic but equally compelling. A magazine leads a double life. It is not only a means of communication. It is also a business. Our life blood as a business is circulation. We must make our readers *want* to come back to the newstand every month and plunk down that quarter.

That distinction in aims is of course why a magazine is something besides a periodical textbook. But it is also why a magazine can bring to the classroom assets that are not to be found in more formal teaching materials.

An editor sometimes envies a teacher his captive audience. You can give 'em what they ought to have. We have to give 'em what they want. That means that sometimes important developments of science must be passed over because they do not have wide reader

* Presented at the Physics Section of the Central Association of Science and Mathematics Teachers November 23, 1951 at Cleveland, Ohio.

appeal. For that reason, if no other, a magazine can never replace a course in science. At the same time we must follow the news—and we may hit a subject this month and not deal with it again for a couple of years. Similarly, we must concentrate on new developments, rather than going over the established principles of scientific theory.

There's an exception to this. From time to time we do take up some of the problems of basic science—but in terms of their effect, rather than the theory. For example we did a picture story on friction and inertia in terms of the forces needed to start and stop vehicles. This series shows the reader how he can do simple experiments at home with no more elaborate apparatus than the average kitchen or tool drawer can supply. I wouldn't propose these simple experiments as a substitute for the relatively elaborate ones that the textbooks have to offer, but they supply a basis for projects that the student can carry out on his own, completely outside the classroom.

The fact that we must attract our audience all over again each month dominates our editorial approach. So does the fact that our readers have a wide range of background knowledge of science and come from a wide range of age groups and economic levels. You can sharpshoot with a rifle, we have to blast away with a shotgun.

This means, for one thing, that we must be simple and easily understood at all costs. The language has to be that the average man can understand without a dictionary. This isn't easy. We sometimes wish that we could send someone along with each copy of the magazine to explain a particularly complicated subject. But the discipline is unchangeable—everything must be in the story itself.

And words aren't enough to tell a story—if you want to do it simply. Pictures take up at least 50 per cent of the space in *Popular Science*. They are so important that sometimes we leave a story out if pictures can't be used to tell it. Pictures can undoubtedly help you to tell your story—and a good place to find them is in science magazines. Incidentally, *Popular Science* makes use of its pictorial emphasis to put out film strips that are intended directly for classroom use. These are based on one subject in the magazine each month and are available to schools on a subscription basis.

But using lots of pictures—and writing simply—are only the beginning of our efforts to make our readers *want* to learn. An important element is making our reader identify himself with the story. That means telling it in terms of its impact on his life, bringing science out of the laboratory and research project and relating it directly to the life of the average man. Atomic physics, for example, as *Popular Science* tells about it, isn't just a matter of electrons and neutrons and other mysterious and invisible particles. It's tracing the proc-

esses of the body to learn how diseases conquer man. It's submarines and airplanes that may run differently and better than any we've ever had. The average reader may be indifferent to atomic particles in themselves, but when you make them matters of work and play, life and death—*his* work and play, *his* life and death—his interest quickens immediately.

Aimed directly at the same goal is our "story" approach. Often, even difficult technical subjects can be made attractive by the use of anecdotal material. A color TV tube, for example, can make pretty hard reading—particularly when it has to be differentiated from several similar tubes that work on slightly different principles. But if you tell how a hot-shot atomic scientist worked it out as a hobby in his home workshop, then the reader is in the middle of how it works before he realizes it. Of course this is scarcely novel—Archimedes has been jumping out of the bath tub for two millenia.

With this approach, the science magazine offers you, the teachers, a number of advantages. It is written simply and presents its material with considerable salesmanship. It provides a bridge between contemporary life and the classroom. It offers a great mass of illustrative material for the taking. It gives the human background of scientific progress that is often hard to find elsewhere. And it does something else. I don't need to tell you that scientific research—and its applications—are today moving with express train speed. No matter how up to date a textbook is this fall, by next September the news will have outstripped it. No school system, of course, could afford new textbooks every year. Fortunately there's no need to.

The science magazines do this job for you. You'll find the great bulk of scientific progress covered in such a magazine as *Popular Science*. For more intensive coverage of such fields as medicine and chemistry, archaeology and anthropology, the Sunday science sections of the *New York Times* are valuable. So is *Science Service*. For more advanced students, approaching the college level, the *Scientific American* provides stimulating reading matter.

To show the student the relationship of science to the living world around him, to supply pictures and news of the latest exciting events in that world, to stimulate him to think about science outside the classroom as well as in it—these are the jobs the science magazine can do for you. It makes *Popular Science* your ally in a project in which we both are deeply interested—making the American people *want* to know more about the forces that are transforming our lives—the forces, sometimes helpful, sometimes terrible, that are set in motion by *living* science.

FORTY DEMONSTRATIONS IN ONE CLASS PERIOD

Marvin D. Glock
Cornell University, Ithaca, N. Y.

There were all kinds of boys and girls in the science class. Some were bright; some were dull. Many were interested; a few were bored. A number came from wealthy homes; a sprinkling had parents on the verge of poverty. Most had their physical needs supplied, if not their desires. Mary and Bill had traveled widely and they had access to good books and magazines in their homes. Ralph and Jack had never been outside of the Centerville Community, and castoff comic books was their reading fare outside school hours. When Mr. Johnson demonstrated osmosis that morning there were forty youngsters in this class and forty interpretations were made of what they saw and heard. For some, meaning was rich and pregnant; for others, it was shallow and sterile. Each boy and girl brought meaning to the learning setting in the light of his background of experiences—his apperceptive mass. No matter whether it is a chapter to be read, a field trip to be taken or a lecture to be listened to, each pupil will benefit in terms of past knowledge, attitudes and skills which he must use to learn the new.

The author was teaching science in a little Nebraska town during the terrible dust storms of the 1930's. Pupils learned about this disaster firsthand. Dust clouds hid the sun and they experienced the need of having lights burning all day. Dirt was blown high along the fence rows just like snow in winter. Even well built houses reeked with the ever-present dust.

Pupils in other parts of the country learned about the dust bowl through the newsreels. Some read about conditions. Others heard about the tragic development from a firsthand observer.

A science class discussion on wind erosion would certainly have had a variety of meanings for a group of youngsters with such heterogeneous backgrounds. Similar to the story of the blind men and the elephant, understanding is dependent on experiences. The man who grabbed the elephant's leg and likened the animal to the stump of a tree did not have a workable concept of the beast. The youngster who had actually breathed the dust, felt the ever-present griminess, and had seen the destruction of good soil would have had a richness of background to give the fullest meaning to the discussion. In contrast, the individual who had experienced dust storms vicariously would have found it much more difficult, if not impossible, to form as adequate a construct of wind erosion as his peer.

There is no difficulty in motivating the former child either. This is the real thing! This has social utility. There is no difficulty in showing belongingness to life for him. He is aware of its importance. Retention is no problem either. Understanding is a criterion for remembering.

But this is obvious. As teachers we are aware of many of these striking individual differences. Do we realize the differences, however, when they are not so dramatic? Is our philosophy of teaching such that we consider possible implications of the varied apperceptive masses of youngsters in all learning? Do we concern ourselves with the very real problem that youngsters interpret everything they see, hear, or read in the light of their previous backgrounds? To teach effectively we must start where the learner is. Gaps must be bridged or the pupil will be stranded—frustrated—and unable to learn the new in terms of the old. Boys and girls must form their own concepts. Teachers can only manipulate the learning environment. They can provide opportunities for the children to see, hear, and feel the new for them in the environment. Teachers can guide learning to make for better understanding of the old. They cannot give constructs to their students. It is, therefore, of primary importance that pupils be ready to learn.

A typical group in any grade will have achievement and ability ranging from five to seven grades.[1] To emphasize the meaning of these existing facts let's be specific. In a ninth grade class we are likely to have youngsters who read at the sixth grade level and some who can read as well or better than the average high school senior. The spread is often much greater. It is futile to give a freshman a science book at the ninth grade level of reading difficulty if he can only comprehend sixth grade level material. He just won't be able to read it. The average four year old could do no better with a preprimer. If the reader can't bring to the printed page the techniques, the experience, the vocabulary, etc., necessary for interpretation, he is confronted by just so many nonsense syllables.

It does no good to exhort him to concentrate, to read it again or to apply himself. In fact, it may be harmful. Certainly self confidence isn't generated by frustrating experiences in which there is no opportunity for success.

"Horace Mann, in his Annual Report in 1838, said:

"I have devoted especial pains to learn, with some degree of numerical accuracy, how far the reading, in our schools, is an exercise of the mind in thinking and feeling, and how far it is a barren action of the organs of speech upon the atmosphere. The result is that more than 11/12ths of all the children in the reading classes in our schools do not understand the meaning of the words they read;

[1] E. L. Cornell, "The Variability of Children of Different Ages and Its Relation to School Classification and Grouping," *Educational Research Studies*, No. 1. University of the State of New York, 1937.

that they do not master the sense of the reading lessons, and that the ideas and feelings intended by the author to be conveyed to, and excited in, the reader's mind, still rest in the author's intention, never having yet reached the place of their destination."[2]

There is an effective solution to the problem. We must make reading materials of sixth grade difficulty available for this pupil. This is a practical way of starting where we find the child. There is an abundance of books and pamphlets now available for science teaching. In a number of instances it is possible to obtain reading difficulty. In others you as a teacher will need to determine this level.[3] Once you have done this, it is an easy matter to suggest readings to other students in relation to their test scores.

Below are some sources with which the science teacher will want to be familiar. Although many science books are listed as satisfactory for the seventh and eighth graders or below they will be at a level of difficulty which is mandatory even for some twelfth graders.

Associations, Educational Organizations, etc.

American Library Association, 50 East Huron Street, Chicago.
Publishes *Booklist* which is a guide to new books. It also makes available frequent selective lists.

Association for Childhood Education, 1201 16th Street, N.W., Washington, D. C.
It also publishes reviews and periodic booklists.

Child Study Association of America, 132 E. 74th Street, New York 21.
Regularly publishes bibliographies which include science books.

Extension Service, New York State College of Agriculture, Cornell University, Ithaca, New York.
A very helpful source is one of the Cornell Rural School Leaflets, September 1949, Volume 43, Number 1, *The Elementary Science Library*. Miss Eva Gordon has done science teachers an outstanding service in reviewing the books published during the past ten or eleven years.

H. W. Wilson Company, 950 University Avenue, New York City.
Publishes both *Book Review Digest* and *Children's Catalogue*.

The University of Chicago Library, Chicago.
Publishes the *Bulletin* of the Children's Book Center.

Books for Science Teachers

The books below contain excellent bibliographies of science books suitable for various levels of reading ability.

Blough, G. O., and Huggett, A. J. *Elementary School Science and How to Teach It*. New York: Dryden Press, 1951. 544 pp.

Craig, Gerald F. *Science for the Elementary-School Teacher*. New York: Ginn and Company, 1947. 561 pp.

Croxton, W. C. *Science in the Elementary School*. New York: McGraw-Hill Publishing Company, 1937. 454 pp.

Heiss, E. D., Obourn, E. F., Hoffman, C. W. *Modern Science Teaching*. New York: The Macmillan Company, 1950. 462 pp.

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[2] Horace Mann, quoted in a speech by Frank L. Weil, "Apathy—The Enemy of Democracy," *Proceedings of the Eighty-Ninth Annual Meeting*, Vol. 89. Washington, D. C.: NEA, 1951.

[3] If the reading grades of your students are available (easily obtained from standardized reading tests) a book can be graded for difficulty by allowing several students to read to you orally. If no more than five out of one hundred running words are too difficult the material may be considered satisfactory for the individual.

PERIODICALS (especially good for new books)

Audubon Magazine, National Audubon Society, 1006 Fifth Avenue, New York City.
Horn Book, Horn Book, Inc., 264 Boylston Street, Boston.
Natural History, American Museum of Natural History, 79th Street at Central Park West, New York City.
Parent's Magazine, Parent's Institute, 9 E. 40th Street, New York City.
SCHOOL SCIENCE AND MATHEMATICS, Glen W. Warner, Editor, Lakeville, Indiana Central Association of Science and Mathematics Teachers.
Science Education, Clarence M. Pruitt, Editor, College Station, Stillwater, Oklahoma, National Association for Research in Science Teaching, National Council on Elementary Science and Association of Science Teachers of the Middle States.

There are other vicarious and firsthand experiences which children can enjoy and which develop their reading ability. The motion picture, the field trip, demonstrations, laboratory work, etc., are only a few of the many opportunities which provide boys and girls with the kind of background necessary to understand the new. We do not mean to imply that teaching should be sugar coated or diluted. We suggest that work type reading isn't easy. However, we do emphasize that it should be possible for the student to have success with his assignments.

In most instances difficulty in reading comprehension won't be solved by aural presentation of material of comparable difficulty. There is evidence which shows substantial relationship between reading and listening comprehension.[4] This can be interpreted to mean that there are more fundamental differences among pupils' comprehension than factors of reading skill. There are differences in native ability, in opportunities to interpret and solve problems and of course, as mentioned, varied backgrounds of experience.

It is not unusual then to have forty demonstrations during our science period. Each pupil will bring to it such varied experiences, achievement and ability that interpretation must be different. This we cannot prevent and we would not want to do so if we could. Good teaching implies an increase in these differences—not the molding of a homogeneous group. The more the teacher provides opportunities for the brighter students to progress and the less she restricts them to class routine, the greater will be the differences between these more gifted youngsters and their less fortunate fellows. Given the opportunity they learn faster and retain better. The old saying, "Easy come, easy go," has no foundation of fact.

Good teaching implies, however, that effective learning is possible for most pupils. It concerns itself with making the classroom experiences meaningful. Because pupils are at various degrees of readi-

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[4] H. Goldstein, "Reading and Listening Comprehensions at Various Controlled Rates," *Teachers College, Columbia University, Contributions to Education*, No. 821, 1940.

ness, preparation for learning is necessary. Guided learning is directed toward the individual. It isn't a "shot gun" approach at the group with the hope that some at least will be hit. If we are to start where pupils are, their preparation will be different. Some will need to read widely to build a background for certain topics. We must be familiar with the kinds of materials with which the individual can profit. The apperceptive mass of others will be developed through films, field trips, and other vicarious and firsthand experiences. Meaningful learning does not imply the same kind of product in the final result. In terms of its comparative richness there may be only contrast among the various boys and girls. Yet classroom experience must be meaningful to everyone.

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ATOMIC ENERGY CONFERENCE

Development of an educational program designed to spread information on the facts and future of atomic energy was announced today by Michigan State College.

College officials said the first phase of the program would be a two-day conference titled "Atomic Energy and the Future" scheduled May 20–21.

Specialists in peace time usage of atomic energy from the Atomic Energy Commission's Argonne National Laboratory, Chicago, have been invited to take part.

Invitations also have gone out to nuclear energy experts from the Massachusetts Institute of Technology and the University of North Carolina.

M.S.C. specialists who have been conducting research with radioactive isotopes will also contribute.

Both the Dow Chemical company, Midland, and the Detroit Edison company have agreed to cooperate.

Idea behind the program is to make information concerning atomic energy available to those who might be able to apply it in their special fields. College officials say that the distribution of facts and information on nuclear research has been poor.

Emphasis in the conference will be placed on possible uses of atomic energy in industry for power generation. Planning officials are operating on the assumption that persons attending will have no prior knowledge of the subject.

Plans are being made to handle several hundred persons from Michigan and from nearby states. All sessions will be opened to the general public. Housing will be available in the Kellogg Center for Continuing Education on the campus.

Further information may be obtained from Prof. Donald J. Renwick, of the mechanical engineering department, who is program chairman, or from Stanfield Wells of the Continuing Education Service.

BACTERIOLOGY UNIT PROJECT

SIMPLE TESTS FOR ANTISEPTIC AND GERMICIDAL ACTIVITY

ARTHUR H. BRYAN
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Projects in the Bacteriology and Hygiene units in High School or Junior College Biology can be made objective with instructional as well as research values accruing there from.

Ordinarily in most Biology classes nutrient agar plates are exposed to air, contaminated water, flies feet, finger contact, mouth wash water or dust etc., to show colony growth of bacteria, yeasts and molds.

Colony growth can be shown just as effectively as in previous demonstrations, but in addition, experiments to evaluate the bacteriostatic or germicidal activity of any of preparations of interest to the class may be made as an enrichment to the usual work.

Liquid antiseptics, disinfectants, mouth washes, tooth pastes; germicidal soaps, antiseptic, bacteriostatic or antibiotic ointments may now be readily tested by a visual method for their germ killing ability or bactericidal activity. A piece of round blotting or filter paper is soaked in the liquid antiseptic to be tested for one minute, and then dropped on the center of a petri dish containing nutrient broth.

If soaps, toothpastes, face creams, or ointments are to be tested for germicidal or diffusion activity, a hole is cut into the center of the hardened nutrient agar with a smooth mouth test tube, and the circumscribed media lifted out with an appropriate sized spatula. A drop of liquid broth may be dropped in the center of cup for the test substance to contact.

The nutrient agar broth should be made according to standard methods of content and preparation, and found in any bacteriology text such as the author's "Principles and Practice of Bacteriology" 1951 edition, Barnes and Noble Publishers.

The culture when cooled to 40°C. is seeded with the test organisms by transferring loopfuls of colony growth to the media. The test organisms are usually mixed infection labile staphylococci, streptococci, or pure strains of either such as Staphylococcus aureus, or Streptococcus viridans. A more resistent check test organism might be an aerobic spore-bearer such as the Bacillus subtillis, common air or water contaminant.

The seeded nutrient agar is then poured into the petri dish and allowed to cool slowly so as to harden consistently throughout the culture media. The lower portion of the dish should be filled to at least ¾ of its capacity

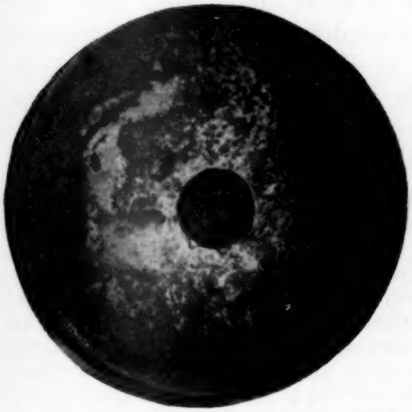

FIG. 1. No germicidal activity. Test organisms grow right up to the cup. No diffusion either.

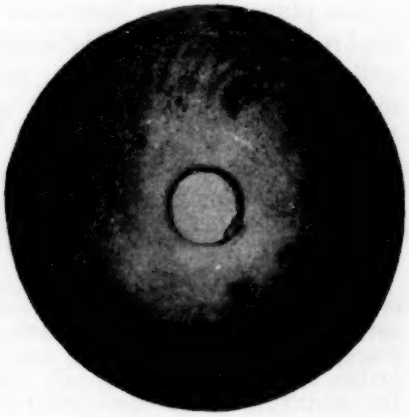

FIG. 2. Strong antiseptic activity. Organisms are inhibited 3–5 mm. from cup of antiseptic in center.

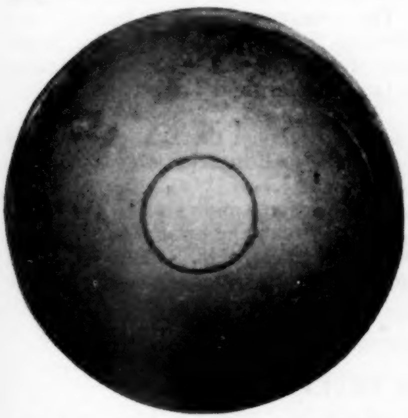

FIG. 3. Very powerful antiseptic, good diffusion and able to kill streptococci, staphylococci and air contaminants.

FIG. 4. No activity against mixed streptococci and staphylococci.

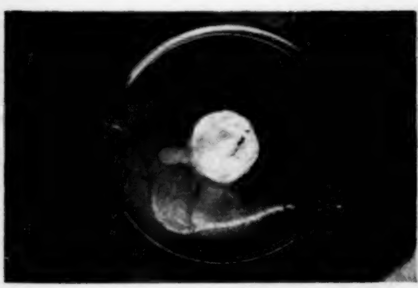

FIG. 5. Half flooded plate with arsenic antiseptic and cup. Good activity.

FIG. 6. No germicidal activity. Organisms as colonies grow to the cup.

The plates are now incubated for 24 to 48 hours, after which the final readings are made. The width of the diffusion zone is measured in milimeters, and is the visual zone of diffusion. The sterile zone is measured also, and compared with a standard antiseptic such as 5% phenol.

SPECIALIST FOR MATHEMATICS IN THE U. S. OFFICE OF EDUCATION

The U. S. Office of Education has provided additional services to the teachers of mathematics in the secondary schools through the appointment of Dr. Kenneth E. Brown, Specialist for Mathematics. His services will be available to State departments of education, universities, and groups of teachers of mathematics. His activities may include conferences, workshops, and other activities that contribute toward improvement of the teaching of mathematics in secondary schools.

Dr. Brown comes to the Office of Education from the Department of Mathematics, University of Tennessee, where he was the mathematics consultant to teachers of the public secondary schools. He has had teaching experience ranging from the elementary to the college level. The colleges included in his wide experience are: New Jersey State Teachers College, Paterson; East Carolina State College; Wagner College; Colorado College of Education, Greeley; University of Oklahoma; University of California at Los Angeles; and University of Tennessee.

Dr. Brown is a native of Oklahoma, where he received the B.S. degree. The M.A. degree was granted by the Colorado College of Education and the Ph.D. from Columbia University.

The interest Dr. Brown has in mathematics education is indicated by the book, *General Mathematics in American Colleges*, and the following articles of which he is the author: "What is General Mathematics?" "Is General Mathematics on its way out?" "Why teach Geometry," and "The content of a course in General Mathematics."

PERCH POPULATION PETERING-OUT

Evidence to support the theory that overpopulations of fish in lakes often result in stunting has been obtained by biologists studying the perch population of Lake Mendota, a large lake bordering the University of Wisconsin campus.

Lake Mendota is one of the "most studied" lakes in the world, with accurate records running back 50 years. In 1916, scientists estimated the perch population at about 15 million, and records from 1905 show that "a single man sometimes secured over 800 perch a day." About 10 years later it was reported that "the usual catch of a professional fisherman, fishing through the ice with a line and two hooks, is from 200 to 400 perch a day."

During the past years a catch of 10 perch per man per day has been considered about average—but the perch are more than twice as big.

"The yellow perch of Lake Mendota during the last 50 years have decreased considerably in numbers," John E. Bardach, a former University of Wisconsin biologist now with Iowa State Teachers College, reports in a recent scientific journal. "During that period their average size has more than doubled." Bardach's work was conducted as part of the research program of the UW Lake laboratory under the direction of Prof. Arthur D. Hasler.

Bardach points out that other biologists have also found that fish sizes increase when populations are reduced—supporting the idea that to have an adequate supply of big fish it's often necessary to do some thinning.

TIMBER'S TRIBUTE TO MAN

B. Clifford Hendricks
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"High in Oregon's Cascade Range two fallers set their saw to the base of a proud Douglas fir. Roots in the shadow, crown in the sun, the great tree thrusts up straight and true, a mirror copy of hundreds of its kind crowding that verdant valley."[1]

What happens to this "felled" tree and millions of others of its kind that are being thus brought down? Certainly not what happened to the trees at the hands of the first settlers. They sought a place to build and to till instead of a competence from the sale of timber's tribute." Those first comers in northwest United States were more likely to lament:

"I arrived flat broke in midwinter,
  I found it enveloped in fog,
And covered all over with timber,
Thick as hair on the back of a dog.

I took up a claim in the forest,
  And set myself down to hard toil,
For two years I chopped and I labored,
  But I never got down to the soil."

They wished to get down to earth by cutting down the trees. "Burn, remove and destroy; get them out of the way," was their cry.

But for the lumberman's tree, a new service awaits after its tumble to earth under the bite of the blade of that saw. Its offering, during its verdant life-time, of: shade, shelter, soil fertility, soil permanence, not to speak of food and ornament, gives way to a post-mortem tribute of unexpected diversity, a largess to man's ever growing needs. A casual survey lists: tool handles, ball bats, skiis, furniture, construction lumber, fire wood, rolling pins, butcher blocks, tooth picks, musical instruments and even wooden-headed Charley McCarthy. So many are the items that the United States may be correctly called "a veritable wood work-shop."

It appears at once that a complete catalogue of these, almost numberless "tributes" to man's needs, would exceed the space allowance of this paper. So limits must be set. In a number of instances wood's use is such as not to be readily identified; it appears to be camouflaged, as it were. It will be the plan, in what follows, to get a few of these uses from "under cover."

Ships at Sea

Old Ironsides, with "her tattered ensign," the name not-with-

[1] Brown, Andrew. *National Geographic.* 100: 109–140 (July, 1951).

standing, was constructed essentially of wood. Her masts were easily identified as trunks of trees with limbs lopped off. But a look at an Essex-type air-craft carrier certainly does not class it as of timber construction. It is said, however, that her flight deck has "two and one third acres of edge-grained Douglas fir three inches thick" in its making. This huge bulk of lumber had to be "released" from the trunks of many trees. As a sculptor busy with his hammer and chisel said he was "releasing an angel from the marble slab" so the saws of the mill "release" the flooring for that air-craft carrier. The saw mill makes the fallen tree into shapes more adaptable to construction needs.

But in doing so there is much discard in the form of bark, slabs and saw dust. It is stated that "only forty-three per cent of all wood handled in the United States goes to salable (not fuel) products, twenty-two per cent is burned as fuel and thirty-five per cent not used at all." As will be related presently, up-to-date saw mill sites are now so "integrated" that this, over one third, waste may be salvaged.

Peeling Plywood

That thirty-five per cent represents economic loss for the mill. If the sale value of the forty-three per cent can be lifted, such increase may, in a sense, offset that wastage. Thus the most superior portion of the logs is often given to the manufacture of plywood.

The tool used looks very much like a huge lathe. "The bark-free (log) is rotated against (its) long and tremendously heavy knife. This knife peels off a thin ribbon of wood known as a veneer sheet which varies in thickness from one-tenth to three-sixteenths of an inch. These sheets are kiln dried (punched knot-free and patched) then united in a hot press under pressure of 180 pounds per square inch." The sheets are criss crossed before going to the press. "These united veneer sheets are known as plywood."

"When the veneer sheets are (peeled) from the (log) you witness the full history of the tree. The sheets show many more imperfections as the great knife cuts closer to the heart of the tree. The sheets (actually) finally become too knot-flecked to be useable."

Many of the "knot-flecked" sheets are used, however, by the help of a process known as "plugging." Before the veneer sheet is sent to the press, if faulty, it is passed under a sort of punch which cuts out the knot or other imperfection by a standardized tool so that the hole may be filled by a same hole-sized patch. These patches fit so well that only the experienced eye can detect them in the finished product.

Plywood processing requires the rather "choice cuts" of timber so leaves much of the timber's harvest for other uses. One authority

points out "that during the past year fifty wood chippers have been installed in plywood plants to produce chips as raw material for pulp mills. These machines can produce 1000 tons of pulp per day from what was formerly a left-over wood used only for fuel."

It is estimated "that Oregon, Washington and California (have) 246 billion board feet of harvestable old-growth Douglas fir timber. Of this, seventy billion feet is considered of quality suitable for plywood manufacture." Enough raw material to support the current rate of plywood manufacture for at least forty years.

Forest's Fiber

"Seeing double through tree bark" is the rather sensational description of a recent use of wood fiber. In this case the fiber from the bark of the Douglas fir was ground to a fine powder. It was then mixed with about one third its weight of phenolic resin and modifiers. When proper proportions of the mixture is made, extreme pressure condenses it into a solid plastic-like form with a shape determined by the mold. The "seeing" is through glass lenses held in place, for stereoscopic viewing of pictures, by the frame made of the powdered bark mixture.

Wood fibers are prepared from either the bark or from wood chips. The Weyerhaeuser Company calls its bark fiber by a trade name, Silvicon. Other trade names of marketable fiber raw materials are: Silvicel, Silvatan and Silvawool. Silvacel, Silvatan and Silvacon are sold to oil drillers for use in control of drill mud. Silvawool is used for house insulation.

So called fiberboard is, in contrast with saw-mill board, a fabrication product rather than a "released" article. It is made from wood fiber or wood pulp which are results of reprocessing wood. These boards are formed by mixing the fibers or pulp with binders and then subjecting it to great pressure in molds of the desirable shapes and sizes.

Pulp not Always for Paper

Last December a Canadian newspaper carried the head lines, "Newsprint Cuts Down Forests." It stated that by 1960 seven million tons of paper will be required in comparison to the 1950 consumption of five million nine hundred thirty-seven thousand tons. It is estimated that such a quantity will require more than two hundred million trees annually. This would call for an unprecedented reforesting program.

But pulp consumption is not limited solely to the paper industry. A listing of its uses calls to mind gun cotton, lacquers and artificial cotton materials such as rayon as well as a number of new type boards other than fiber board such as wall board and hard board.

Those in a position to known expect that these pulp products may presently become active competitors with plywood for many of its present uses.

Use All the Wood

An attractive aspect of pulping from the lumberman's angle is that it can be made from saw mill waste which in pioneer days was burned in order to remove it from the mill site. Great quantities of this saw dust and mill ends are still used as fuel in the power plants that generate the electricity for the manufacturing power. If, instead, these waste materials were pulped and then made into hard board the money return from them would be about tripled. Such a reward for these new camouflaged uses of saw mill waste is giving very general support for a new slogan now being publicized, "Use All the Wood."

Before the slogan was proposed, however, the more alert companies were using the plan much used by Weyerhaeuser; that is "We group our mills." Upon a given mill site they have not only the saw mill and its power plant but a dry kiln, a plywood plant, a pulp mill, a presto-log plant, a bark products plant and a planing mill. Thus it is evident that not only is there economy in short hauls for moving the raw materials but all scrap materials such as bark, saw dust, slabs and mill ends may be routed to processing plants for a more marketable utilization. Another name for these labor saving lay-outs is "integrated industry."

A Jobless Remnant

Pulping for paper has its private need for salvage for discards. Pulp's remnant is lignin. It is a natural cementing material holding the desired cellulose fibers together but must be removed. If the cellulose is to be used in making the better grades of paper the lignin is dissolved in the digester by bisulfites or alkali solvent solutions. Up to the present this solution has been either dumped into streams or evaporated and burned to recover the pulping chemicals. This is an obvious waste if lignin has any sale value.

"Next to cellulose lignin is the most abundant chemical component of plants. Coniferous woods contain as much as twenty-four to twenty-eight per cent. The amount of lignin burned or wasted is equal, on a dry weight basis, to twice that of the non-ferrous metal production of the whole United States. This total does not at all represent the amount of lignin that could be made available if sufficiently extensive and valuable uses could be found for it."[2]

[2] Magazine, *Wood.* 139 North Clark St., Chicago. November, 1951. Page 54.

Lignin can be hydrogenated under heat and pressure. Three liquid products result: cyclic alcohols, phenolic compounds, and neutral oils. Methyl alcohol is also obtained and in larger yield than by destructive distillation of the wood. There are some ten or more small scale uses known at present but even so here is an abundant chemical looking for a man-sized job.

THE DATE OF EASTER

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Immediately following the so-called fall of the Roman Empire near the end of the fifth century, mathematical scholarship had reached a very low ebb in Europe. The principal mathematical works in use were handbooks called ***computi***, which gave rules for computing the variable date of Easter. To obtain an idea of the nature of this problem, consider a modern method for finding that date. This method was contributed by the great German mathematician, Karl Friedrich Gauss, in the early part of the nineteenth century.

Let N be the year in which the date of Easter is to be determined. Then let the ***remainders*** of the following divisions be designated as indicated: $N \div 19$ with a, $N \div 4$ with b, $N \div 7$ with c, $(19\,a+x) \div 30$ with d, and $(2b+4c+6d+y) \div 7$ with e, where $x=15$, $y=6$ for the Julian calendar. For the Gregorian calendar, which we now use, the values for x and y are given by the following table:

Years	x	y
1583 to 1699	22	2
1700 to 1799	23	3
1800 to 1899	23	4
1900 to 2099	24	5

Then the date of Easter, if in March, is given by

$$22+d+e; \qquad (1)$$

if in April, it is given by

$$d+e-9. \qquad (2)$$

This statement apparently leaves the month undetermined. However, the correct month is found in this way. Either (1) or (2), but not both, will yield an impossible date, e.g., a date less than one or a

date greater than 31. The *possible* date, with its corresponding month, is then chosen.

To arrive at a better understanding of this situation, consider the following. Since d is a remainder from a division by 30, and e is a remainder from a division by 7, we have

$$0 \leqq d \leqq 29.$$

$$0 \leqq e \leqq 6.$$

Adding,

$$0 \leqq d+e \leqq 35. \tag{3}$$

But March has 31 days so that, from (1),

$$22+d+e \leqq 31,$$

or

$$d+e \leqq 9.$$

Hence, $d+e=0, 1, 2, \cdots, 9$, and only these values give possible dates in March. But, by (2), these values also give impossible dates less than one in April. From these values and (1) it follows that Easter cannot come before March 22. A date in April cannot have a value less than one, hence, from (2),

$$d+e-9 \geqq 1,$$

or

$$d+e \geqq 10.$$

But, by (3), $d+e$ cannot exceed 35. Hence, again by (2), $d+e=10, 11, 12, \cdots, 35$ give dates that are possible in April, but, by (1), these values give dates that are impossible in March. Therefore, in all cases, either March or April is excluded, and we choose the remaining month and its corresponding date.

But, if $d+e=35$, a modification is required. The value $d+e=35$ indicates April 26 by (2). But, in this case, we must substitute April 19. Also if $d=28$, $e=6$, and $a>10$, April 25 as given by (2) must be replaced by April 18. It follows from this discussion that Easter may not occur later than April 25.

Plastic safety lenses, half the weight of their glass counterparts, have been developed to withstand breakage and to protect industrial workers' eyes. They are resistant to splashing chemicals, welding spatter, emery wheel sparks and the impact of hard, small, high-velocity particles. The "glasses" have high scratch-resistant qualities.

SOME CHALLENGING PROBLEMS IN TEACHING HIGH SCHOOL SCIENCE TO GIFTED CHILDREN*

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The very existence of the United States as an independent nation is now being threatened. We, as a people, are deeply concerned. Every rational citizen now knows that one important factor in our survival, if we do survive, will be the effective use of science and the scientific method. A much higher percentage of our gifted young people must be well trained in science. Speed in this matter is urgent. There is now a manpower bottleneck in scientific research, and it is estimated that this shortage is likely to become more serious within the next ten years.

We in education must do what we can immediately. Careful consideration must also be given to long range planning. There is the possibility and probable desirability of establishing high schools of science. Such schools may be set up on either a city-wide basis in very large cities or on a state-wide basis. The most outstanding school of this kind thus far established is the High School of Science in Bronx, New York, of which Dr. Morris Meister is principal.[1]

In such schools these gifted children will be required and must be willing to withstand the intense "heat" of learning as well as bask in its "bright glow."[2] Dr. Meister says that "In the well-known National Science Talent Search our students have, in nine years, won more scholarships and honorable mentions than the pupils of any other high school."[3] If more such schools are established we should make sure that their graduates are able to retain their complete freedom as well as their moral and intellectual integrity. These graduates should not be forced or pressured to become technicians of the State.

Grouping of students into classes according to their capacities is another plan that has been with us for a long time. Such a plan will tend, because of competition, to stimulate students to work more nearly up to their capacities.

Under any plan, however, the philosophy of the teacher and administrative officers, the selection and organization of content, and methods employed are perhaps of greater importance than the particular administrative organization.

Most of our gifted high school students will for many years to come be taught in regular high school classes in which the class members

* Read at Cleveland November 24, 1951, at the annual meeting of the Central Association of Science and Mathematics Teachers.

[1] Paul Witty, *The Gifted Child*. Pp. 210–234 (written by Morris Meister). 1951.

[2] Jacques Barzun, *Teacher in America*. P. 259. 1945.

[3] Paul Witty, *The Gifted Child*. P. 229. 1951.

will vary much in capacity, in present ability, in interests, in motivation, in ideals, and therefore in their ability and willingness to give sustained attention to school work. Those who are afraid of acceleration advocate enrichment.

Clubs, hobbies, seminars, special projects, special reports, science days, science fairs, and extensive reading may all be included under the heading enrichment. The gifted students can and will, if properly motivated, do the minimum required in a course in much less time than the time taken by the average and slow students. It is the opinion of many experts that this extra time available for the bright students, if not actually wasted, is often employed in such a manner as to bring results that are extremely mediocre in both quality and quantity.[4] More is required under the heading of enrichment than mere busy work which siphons off the excess energy of these gifted children.

The possibility of connecting and integrating science with the subjects which are generally considered necessary as a part of general education is very intriguing. As a matter of fact much of this material is, in actual life, at the side of the road rather than on the main highway. Why not place some of it on the roadside as enrichment material for those gifted children for whom, so far as we are concerned, science is the main thoroughfare.

Phillip Frank has expressed this idea so well that I would like to quote him. "What we actually need is to bridge the gap between science and the humanities which has opened and widened more and more during the nineteenth and twentieth centuries. According to my opinion, this can be done only by starting from the *human* values *which are intrinsic in science itself*. The instruction in science must emphasize these values and convince the science students that *interest in humanities is the natural result of a thorough interest in science itself*."[5]

Much of this sort of thing can be done by the science teacher. Better results can probably be obtained if the teachers from various departments will work together. In this way we may hope that the bright students may attain much more unity between science and such other areas as history, geography, biography, literature, art, processes of thinking, politics, and religion.

At the present time there is much interest in the acceleration of these gifted students. Whether this opinion is a considered conclusion from all scientific studies in the field or, to some extent, a rationalization, it is impossible for the present writer to say. Dael Wolfe, Direc-

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[4] Paul Witty, *The Gifted Child*. P. 219. 1951.

[5] Phillip Frank, *Modern Science and Its Philosophy*. P. 261. 1949.

tor of the Commission on Human Resources and Advanced Training, points out that results of a special study made by Dr. Harvey Lehman of Ohio State University indicate that great achievements have often been made by bright youngsters at a very early age. Mr. Wolfe goes on to say that Dr. S. L. Pressey, also at Ohio State University, has effectively demonstrated "(that) they can do so (develop faster) without damage to health, without appreciable loss of opportunity to participate in extracurricular activities, without loss in quality of work, and with very positive benefit (in) that a larger percentage of those accelerated students graduate from college than is true of equally bright but non-accelerated students."[6]

Many schools in the country have always had a seven year elementary school. The elementary school in the Laboratory Schools at the University of Chicago was reduced to seven years in 1913.

Dr. Samuel C. Boucher, in his book entitled, *The Chicago College Plan*, suggests that exceptionally bright students can, after the completion of six years in the elementary school, three or four years in high school, and three or four years in the general college be well prepared to enter the upper divisions and professional schools of the University.[7] Under such a plan emphasis is placed on the development of competencies rather than completion of courses; the careful guidance of the student so as not to waste time; and the early establishment by the student of long range purposes. These are some of the conditions which will most likely lead to real intellectual interests and to foster at an early age a relatively high degree of intellectual independence which seem to be important traits needed by persons in the scientific professions and by those engaged in scientific research. At present the University of Chicago will allow credit in the general college for certain specified courses taken in high school providing the student passes successfully examinations in these courses when, or soon after, entering the University.

Mere Subject Matter

During my recent opportunity to review some of the literature in the field of Education in general and Science Education in particular I was startled to find how often the phrase "subject matter" was preceded by the words "mere" or "merely." Since that time I have noticed that many of my colleagues in the field of education tend to use these derogatory expressions to minimize the importance of content and to generally present it in a very unfavorable light.

I cannot refrain from quoting from James L. Mursell who says,

[6] Dael Wolfe, "Intellectual Resources." *Scientific American*. P. 42, September, 1951.

[7] Samuel C. Boucher, *The Chicago College Plan*. P. 238. 1935.

"The science teacher who would substitute a general psychological massage for the great verities of his subject would be doing his pupils a very ill turn indeed."[8] This seems to have special application to the training of gifted children.

There are some suggestions which may be made concerning subject matter. Try introducing more biography of noted scientists and more of the history of the development of science. Present some of the history-making scientific experiments of the past and show the successes and failures of the early scientists in the use of the scientific method. Make more of an effort to look out from the interior of the science field into the various related areas. I am here thinking about such topics as "Population Numbers"; "Race Problems"; "Concervation"; "Health"; "History"; and "Religion." Make a greater effort to connect the science being studied with human affairs. Show the connection between the science principles being studied and the popular science of the day.

Frank says that "He (the physics teacher) is generally less trained than the educated layman in forming a well-balanced judgment on such problems as are daily discussed in magazines and lectures about the influence of modern physics on human affairs. . . . Therefore, the graduates in physics will rarely be able to advise the general public on questions which this public regards as relevant for their general outlook on man and the universe."[9]

In what has been said above I do not mean to indicate that we should try to condition these bright students to change the social order, nor to teach important factors and elements here and there which, when synthesized, will lead in that direction. Bright students are experts at the high type of mental activity known as synthesizing. On this point I am in hearty agreement with Dr. Paul B. Sears who says in his recent book, "If social change really is desirable and there is agreement to that effect within the adult community, well and good. But it is adult society and not the school which is the legitimate battleground of social change. . . . To make schools, behind the back of the adult community so to speak, into instruments of operation against the culture, is not education and certainly not sportsmanship.

"Democracy has in its structure other and fairer means of change. Democracy will be preserved not by telling its young what to think, but how to think and giving them the means with which to think."[10]

Try more often to make the initial approach to teaching by way of things rather than principles. My reasons for making this suggestion

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[8] James L. Mursell, *Developmental Teaching*. McGraw-Hill Book Company. New York. P. 14. 1949.

[9] Phillip Frank, *Modern Science and Its Philosophy*. P. 264. 1949.

[10] Paul B. Sears, *Charles Darwin*. P. 107. 1950.

are that: the initial approach is more interesting through things than through abstract generalizations; generalizations are better understood when arrived at inductively; such a procedure is more economical of laboratory material; by such a procedure a well-rounded understanding of a greater number of objects in nature is developed; and such a plan will probably give a much better ground work for later research.

In teaching these gifted children in regular science classes methods of caring for these differences are particularly important. Time given to lesson assigning and lesson hearing should probably be reduced to the minimum. The classroom should take on more of the atmosphere of a work room. It should be well supplied with books, equipment and supplies easily available, and some tools. The bright students should be guided into carefully selected individual and group supplementary projects.

Such methods should be devised as will be best to create real learning situations; bring about a high degree of sustained attention; develop real intellectual interests which will lead to motivation; and give an opportunity for the rapid development of intellectual independence.

There should be at least one little laboratory and workshop where capable and interested students may take the first steps in research. Probably more attention should be given to individual laboratory work. Scientific studies show that individual laboratory work is particularly significant when the objectives are (1) the solving of problems in the laboratory and (2) the gaining of laboratory skills.[11]

Traits and Ideals

Subject matter must be held in high regard. This does not mean, however, that the development of traits and ideals is to be in any way neglected. These objectives have equal importance with subject matter and are closely related to and interwoven with the effective learning of Content. Our noted scientists have differed much in brightness. Their success has always depended upon more than brightness. Spencer was brighter but Darwin was the better scientist. One trait common to most, if not all of our noted scientists has been and is an intense driving interest, a desire to learn, a strong motivation to the point of absorption in their chosen field.

In the literature on this subject, some of which is based on evidence of the performance of gifted high school graduates in college, high schools are often criticized for not stimulating a desire to learn; not training properly in will power and fidelity to a purpose; lack of

[11] Harry A. Cunningham, "Lecture Demonstration versus Individual Laboratory Method in Science Teaching." *Science Education* 30: 70–82. March, 1946.

clear, obtainable and measurable standards which are high and difficult but not impossible; not developing in students a willingness, for future goals, to experience things which are endurable but not necessarily pleasurable; failing to make clear the distinction between interest and pleasure. A thing can be interesting without, at the moment, having pleasure attached to it. In fact, arousing genuine intellectual interest often seems almost the opposite of "making a subject pleasurable." With these bright children, we certainly want to avoid a philosophy, somewhat prevalent at present, which little by little may lead to educational "self indulgence" and "soft pedagogy."

The teacher of these children must be a master at setting goals far in advance. Unless some attention is given to this, the science class may seem relatively tame and lacking in necessary drive. I would like to see the classes in science be able to compete in this matter on somewhat equal terms with speech, music, and athletics. These future events which may be made goals are such things as: science exhibits; science fairs; projects for high school science days conducted on a city, regional, or state-wide basis; state scholarship examinations; and special examinations which are usually necessary in connection with applications for scholarships at colleges and universities. The teacher should know the "what," "where," "when," "how," and "why" concerning all these things long in advance, should inform the students about them and, if possible, get them to work for the goals which seem desirable. The Ohio Junior Academy of Science conducts regional *Science Days* each spring. Students should already be planning and working on their projects for this event. They should know about the Westinghouse Science Search and the Harvard National Scholarships.

In the New York *Times* for November 18, there was an announcement of 200 scholarships furnished by the Ford Foundations Fund for The Advancement of Education. These provide "tuition plus maintenance up to $1,000 a year at Chicago, Columbia, Wisconsin or Yale Universities." These scholarships are restricted to "high school boys who are under sixteen and one half years of age on September 15, 1952. They may be held only for the first two years of college. At least three-fifths of the scholarships are expected to be won by students who have not completed high school work."

The Scientific Method

It is necessary, of course, that attention be given to the skills and abilities involved in the successful use of the scientific method. Of equal importance is to know at what points we are likely to fail in its use. To be fairly sure that it will be used, even after the necessary skills and abilities are developed, the group of traits known as the

scientific attitudes must be given attention. Finally some feeling of appreciation for the value of the use of this method in intelligent behavior both in the laboratory and in meeting the problems of living seems imperative. After we have agreed on what has just been said it is only fair to indicate a few of the difficulties which may arise in bright and sensitive young minds. If and when such difficulties do appear they are a sign of health in that they give indication of a bright, sensitive, and honest intellect.

As has been very well pointed out by Dr. James B. Conant of Harvard, a good user of the scientific method in the laboratory may, as a matter of fact be, in reality, an unstable personality. Such a person follows strict laboratory procedure in his laboratory work because (1) his reputation, yes his very livelihood, depends upon it and (2) his social setting demands it.[12,13] Such a scientist is not inwardly much concerned about his moral and intellectual integrity. He is likely to follow the leader both inside and outside the laboratory. This is adjustment but it is hard on the soul.

Conflict often arises concerning these matters in people who really and honestly commit themselves to believe what they believe on impartial, objective, rational, and intellectual grounds. They assume, rightly it seems to me, that this commitment made in the science laboratory can be used in fields outside the laboratory.

Here, however, they are likely to find in some areas that the majority of their fellows proclaim as truths certain ideas or generalizations which seem quite irrational, often based on the proclamations or commands of authoritative persons or agencies. Some of the most courageous of our young people may, in the words of Dr. Anton J. Carlson, ask the question, "Verr iss de effidence?" The answer which they get from their neighbors makes their disillusionment complete. Thus, the temptation is very great to accept irrational doctrines outside the field of science rather than face ostracism and isolation. By such a procedure, however, one sacrifices intellectual independence as well as intellectual and moral integrity. This conflict in a sensitive individual—one not yet toughened in the world of reality—may make living quite uncomfortable, especially when one is alone and not busy.[14] It is very interesting to note how some of our most noted scientists squirm on this point.

One solution, not a very satisfactory one perhaps, which is often used for this difficulty is rationalization. To do this one rationalizes an irrational idea and then proceeds to show that the rationalized generalization will stand the test of reason and is really supported by

[12] James B. Conant, *On Understanding Science*. Pp. 7, 8. 1947.
[13] James B. Conant, *Education in a Divided World*. Pp. 119, 120. 1949.
[14] Erich From, *Psychoanalysis and Religion*. Pp. 32, 33, 58, 74–76. 1950.

the facts. Thereafter, the rationalized idea or generalization is defended as the truth. Many examples of this mistake can be drawn from the history of science.

One other difficulty in connection with teaching the scientific method should be mentioned. There is a tendency for the scientist in his laboratory to wish to come very near to certainty. In fact some of the safeguards which the scientist must attend to in his scientific work are that observations must be accurate, extensive, and made under a variety of conditions. Judgment must be suspended if the evidence is inadequate.[15] In the field of practical affairs this attitude is likely to lead to skepticism and uselessness.

These bright young people must, in dealing with practical problems, learn to dissipate certainty. They must learn to act upon what seems to be the best hypothesis, assuming that they have given consideration to all the possible hypotheses and that the course of action decided upon will probably not have very harmful effects upon any individual in case it is later found to be wrong. In other words these gifted students must . . . "learn to act upon the best hypothesis without dogmatically believing it."[16]

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[15] Elliot R. Downing, "The Elements and Safeguards of Scientific Thinking." *The Scientific Monthly.* 26: 231–243. March, 1928.

[16] Bertrand Russell, *Unpopular Essays.* Pp. 27, 28. 1950.

THE KNOW-HOW APPROACH

A UNIT IN GENERAL SCIENCE

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Never in our lifetime have the efforts of secondary school science teachers been so critically challenged, and yet there has never been such a wealth of visual material for creating and sustaining interest appeal. The success or popularity of these helpful teaching aids will depend largely upon how effectively they are used in the classroom. To accomplish this the author has selected a suitable activity: Microscopic Structure of a Typical Leaf.

It is quite generally agreed among school faculties that pupil-teacher activities* help make facts live, but these should be prepared in advance of the guided experiences. To provide an adequate background for this particular ninth-grade general science lesson, the writer suggests a get-acquainted assignment in the form of intelligent, thought-provoking questions. This should provide a rich experience in the social as well as the scientific sphere. Next comes the organized activity, detailed with precise, easy-to-understand instructions and observations. For effective results, the students should be encouraged to make neat sketches, record the data, and interpret the findings independently in their individual booklets. The planned activity is completed by a set of well-chosen, supplementary questions which summarize the salient points. The questions may be given for home work or class discussion.

UNIT: PLANT LIFE

TOPIC STUDY: LEAVES

Introduction

1. In the tropics, date palms are found to have thick-walled leaves. Of what value are these to the plant?
2. Why are green plants said to be constructive while animals are said to be destructive?
3. Suggest a reason for heavy leaf growth on most trees.
4. How do parks in large cities help to cool the atmosphere near them?
5. What processes do leaves carry on? Which of these is the most important to man?
6. In cities where soft coal is used extensively, trees find it difficult to thrive. Why?

* Simmons, Maitland P. *The Young Scientist.* New York: Exposition Press, Inc., 1951. The book contains 35 ninth-grade general science classroom activities with functional and instructive illustratio

7. What is the best time of year to transplant trees and shrubs? Explain.

8. Why are the fumes from a chimney sometimes forced into the air of a greenhouse?

9. How does crowding affect forest trees?

10. Why do cacti manufacture food in their round stems, while most plants make it in their flat leaves?

Directions for Study:

A. Lower Surface of Leaf:

With a razor blade or a sharp knife, scrape off a small *thin* piece of the *under* surface (epidermis) of a tender leaf. Mount it in a drop of faintly tinted water (red ink) on a glass slide. Place a thin cover glass (No. 1) over the specimen. Examine it through the low-powered objective of a compound microscope with a magnification at least 100 times.

B. Cross-section of Leaf:

With a razor blade or a sharp knife, cut across the tender leaf. Examine the leaf, or a cross-section of another leaf (purchased, stained slides) through the low-powered and the high-powered objectives of a compound microscope.

C. Chlorophyll (to be performed only by the teacher):

We wish to study here the effect of boiling fresh green leaves in methyl alcohol (poisonous). Since it is unwise to boil alcohol directly over the Bunsen burner, it is best to devise a steam bath. Support a one-liter beaker half full of water on a wire gauge over clamp attached to a ring stand. Set a 500 cc. Florence flask two-thirds full of the wood alcohol on top of the beaker and fasten to the ring stand. (The laboratory apparatus would be more effective if it were painted a bright color.) Drop several green leaves into the flask and then *gently* boil the water in the beaker from five to six minutes. (Caution: Since alcohol is flammable, keep flame away from the vapor.) Remove the leaves from the alcohol and observe the color of the alcohol and the leaves.

Note to Teacher:

For an interesting experiment to show the cell wall and the movements of the chloroplasts, put a piece of a leaf of the elodea, wandering jew, or begonia on a glass slide. Cover with a drop of salt water and place a thin cover glass (No. 1) over it. Examine it under low-powered and high-powered objectives of a compound microscope.

Count the chloroplasts present in a single chlorophyll-bearing cell.

Observations from Study:

A. Lower Surface of Leaf:

Describe the appearance of the epidermal cells. Give their use.

ACTIVITY: MICROSCOPIC STRUCTURE OF A TYPICAL LEAF

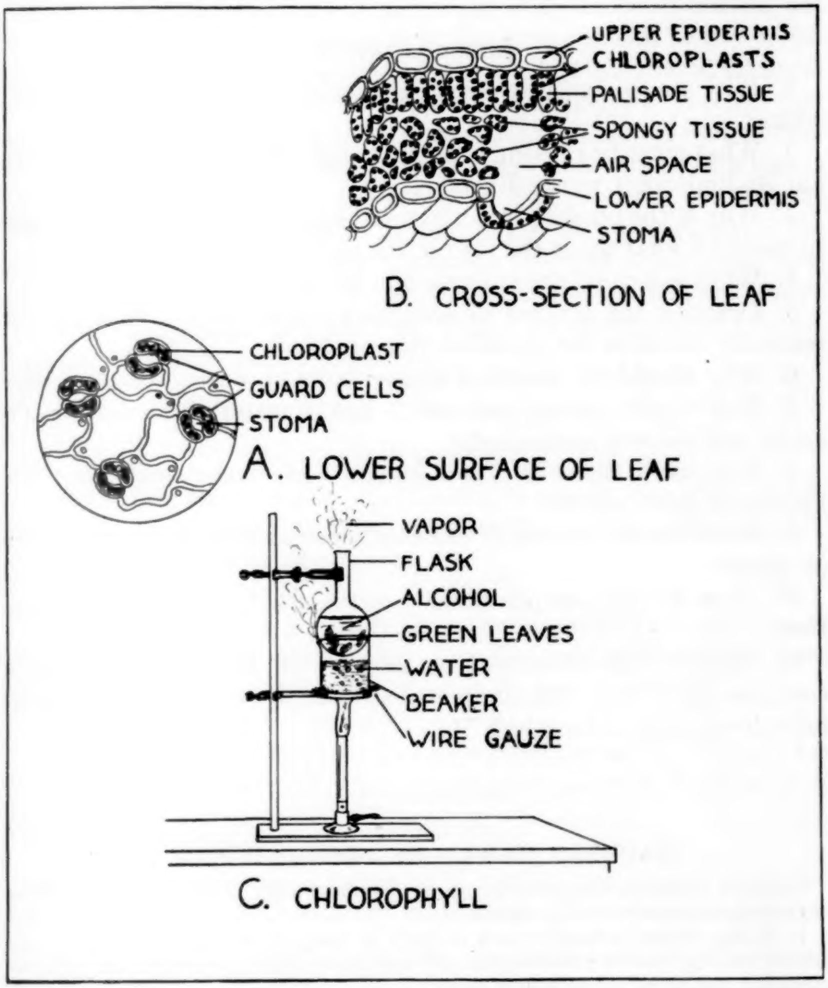

FIG. 1. Internal Parts of a Leaf.

What other parts did you see? How many cells surrounded each stoma? State their function.

B. Cross-section of Leaf:

Name the internal parts of a leaf. State their functions. What cells make the food? Did you find any chloroplasts in these cells? In which layer were the air spaces located?

C. Chlorophyll:

What did the alcohol take out of the leaf? Give the color and function of chlorophyll. What was the original color of the alcohol and the leaves?

Interpretations

1. Why are the inner leaves of cabbage and lettuce when "headed" white?
2. What must be present in plants before the chlorophyll can carry out its important work? Explain.
3. Why is the product manufactured by green plants so important to man? Of what use is the vein in the leaf?
4. What will cause the stomata of a leaf to close?
5. Describe the process of obtaining maple syrup. How do the materials found in the air affect this process?
6. Why should the leaves of house plants be washed occasionally?
7. How would green plants which live in water obtain carbon dioxide and mineral compounds?
8. Why can't the cells of our human body make foods after the fashion of green plants?
9. What are the sources of most cellulose used in the manufacture of paper?
10. How do iron compounds in solution affect chlorophyll production?
11. Explain this statement on an air-wick container—"Air-wick contains more than 125 compounds as found in nature, as well as miracle-working chlorophyll."

TEACHERS SHOULD BE FREED TO TEACH

Concrete remedies suggested by teacher organizations as steps in the direction of freeing teachers to teach, include:

1. Hiring clerks to handle such matters as keeping records, checking on absences, making charts, collecting money and material for various drives, mimeographing seat work, projects and tests.
2. Hiring recreation directors to take over the planning, production and management of school entertainments, benefits and dances, to do yard duty, hall traffic duty, and to supervise high school study halls.
3. Hiring special teachers to take over school clubs and sports.
4. Limiting classes to 25.
5. Providing time during the school day in which the teacher can correct student work and make preparations for the next day.

HEREDITY FOR HIGH SCHOOL[1]

PROBLEMS TO BE SOLVED; CONCEPTS TO BE UNDERSTOOD

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Have you as a teacher in high school had the experience of seeing students work industriously in preparing a mathematics lesson, yet find the biology course too easy or perhaps too difficult to give much time or thought to its preparation? Perhaps you will find that students will become enthusiastic about the study of heredity if you will prepare copies of the following series of questions and assign each section as a daily written lesson. With nearly every question the student is referred to one or more of the concepts. The concepts will become clear when the student studies in connection with the question, the reading matter in the biology textbooks for high school that deal with heredity. Finally, the student must answer in his own words the specific question that is asked. Many problems and much discussion will follow each assignment.

THE CONCEPTS

The Physical Basis of Heredity

1. In sexual reproduction an offspring is usually the result of the fusion of a male germ cell (the sperm) with a female germ cell (the egg). This is called *fertilization.*

References:[2] G, 376; M, 582–3; V, 506.

2. Such an offspring generally shows certain of the peculiarities or characteristics (traits) of its parent. It is obvious that these must have passed from parent of offspring. *This is the fact of heredity.*

References: B, 583–4; C, 598-9; V, 535–7.

3. Since the only materials that pass from parent to offspring are the germ cells, the carriers of hereditary traits must lie in these germ cells.

References: H, 286; V, 537.

4. Since the presence or absence of certain traits in an organism has been shown to be associated with the presence or absence of cer-

[1] This unit of thought was originated by David F. Miller, Chairman, Department of Zoology and Entomology, The Ohio State University, Columbus, Ohio.

[2] The letters refer to high school textbooks as follows; the numbers refer to pages.

B—Baker and Mills, *Dynamic Biology Today*, 1940.
C—Curtis, Caldwell, and Sherman, *Everyday Biology*, 1940.
G—Gruenberg, *Biology and Man*, 1944.
H—Hunter, *Life Science*, 1941.
M—Moon, Mann, and Otto, *Modern Biology*.
V—Vance and Miller, *Biology for You*, 1950.
S—Smith, *Exploring Biology*, 1943.

tain chromosomes, the chromosomes have been called *the carriers of hereditary traits.*

References: H, 286–9; V, 537–40.

5. Each species of organism has a definite and constant number of *different kinds* of these carriers (the N number) in each of its cells.

References: B, 588–90; H, 287–9; V, 518.

6. Since there are two chromosomes of each kind, the total number of chromosomes in a nucleus is twice the number of kinds (the 2N number).

References: M, 580; V, 517–20.

7. The number of traits in an organism may be very great while the number of chromosomes is very small. Chromosomes, therefore, must have parts that govern different traits. *These parts of chromosomes are the genes.*

References: B, 590; C, 599–600; V, 537–8.

8. Since the chromosomes occur in pairs, there must be a pair of genes influencing each trait.

References: B, 590; C, 600; V, 540.

The Function of Genes

9. The genes of a pair may be alike in their expression of a trait. In respect to that trait the organism is said to be *pure line* or *homozygous.*

References: M, 590; S, 500; V, 541–2.

10. When the genes of a pair are contrasting in their expression of a trait, the organism is said to be mixed or *heterozygous* (*a hybrid*) in regard to that trait.

References: M, 590; S, 500; V, 541.

11. In a pair of contrasting genes, one may be expressed while the other remains hidden. The one that is expressed is called *dominant;* the one that is hidden is called *recessive.*

References: B, 591–2; C, 603; V, 541–3.

12. When neither of a pair of contrasting genes is dominant over the other and each is partially expressed, the trait is *blending* or has *partial dominance.*

References: B, 595-6; V, 543.

13. A pair of genes or a combination of pairs of genes of an organism is called a *genotype.* The physical expression of these genes or the heredity that shows is called the *phenotype.*

References: H, 456; S, 487; V, 538–40.

14. The phenotype that results from one pair of genes is called a *heritable unit trait.*

References: S, 474–5; V, 539–41; 561.

15. A trait may be the result of a combination of pairs of genes (multiple factors).

References: G, 482–3; S, 481–2.

16. When the genes of a pair are contrasting, each gene is called *an allele*. A combination of pairs of contrasting genes are known as *multiple alleles*.

References: G, 486; S, 481–2; V, 541, 544–5.

17. All the genes in any one chromosome are joined with each other and remain together so long as they are a part of that chromosome. This is called *linkage*.

References: H, 462; S, 484; V, 547–8.

18. A heritable change in the structure or composition of a gene may result in a new trait. This is known as a mutation.

References: B, 601–2; C, 593–4; V, 549.

The Relation of Environment to Heredity

19. In addition to the hereditary factor or combination of hereditary factors that make possible a trait, the organism must live in an environment that makes possible the expression of a trait.

References: C, 596–7; G, 269; V, 549–50.

20. Sometimes the physical expression of genes will vary with the environment. The variation is in the body cells that are called somatoplasm.

References: G, 507–9; V, 549–50.

21. Genes (the germplasm) usually are not changed by the environment.

References: G, 507–9; V, 549–50.

22. Germ diseases such as tuberculosis are not inherited. A physical condition in which an organism is susceptible to a disease may be inherited.

References: H, 600; S, 208–9; V, 556.

23. Some combinations of genes produce an organism that cannot adjust to the environment, and hence the organism may be unable to reproduce. If reproduction does not occur, these genes will be eliminated. If reproduction does occur, genes will be carried on to the next generation. The transfer of some genes and the elimination of other genes will directly affect the heredity of the species.

References: C, 594; S, 551; V, 558–9, 569–71.

The Problems

Section 1. Heredity and Environment; Mutations

In 1870 the United States Department of Agriculture obtained a new variety of orange tree from Brazil. It grew exceptionally well in

the climate and soil of California and produced an orange fruit with no seeds and of superior quality. This is the Washington Navel Orange that became the most widely grown orange tree in California, all from just one tree that was shipped there.

1. How was it possible to get such a large number of trees from the original one that had oranges without seeds? *Reference:* V, 649.

2. Why would it not be wise to plant Washington Navel Orange trees in Ohio? *Concept* No. 19.

3. Explain also how the importance of heredity is illustrated. *Concept* No. 2.

4. Explain the extent of importance of both heredity and environment to plants and animals and give your reason for the answer. *Concept* No. 19.

5. Man cannot really produce a new variety of plant or animal. How, then, can you explain the development of the original Washington Navel Orange? *Concept* No. 18.

6. Explain what is meant when we say seedless oranges first developed as a result of a mutation. *Concept* No. 18.

Section 2. Dominant and Recessive Genes

When you travel in the Great Plains and semi-desert sagebrush areas of our west, you will see herds of red-coated cattle, always with white faces. These are the Herefore cattle that thrive especially well on short grass in western United States. They are often shipped east to be fattened before being sent to the packer for preparing beef.

Let us think of a particular herd of fine quality Herefords, all of which had horns. In this herd, an unusual happening took place. A bull was born without horns.

1. The hornless or polled condition of the calf as it is usually called was a mutation. Explain what a mutation is. *Concept* No. 18.

2. In the illustration (Figure 1) the hornless bull is crossed with a horned cow. All of the calves are hornless. Explain why we classify this hornless condition as dominant. *Concept* No. 11.

3. Whenever the same kind of recessive gene is present in both parents, the recessive genes may by chance unite in the fertilization of the egg. Such homozygous recessive genes may result in an unusual characteristic. How do we know that the unusual hornless condition where it first developed in the herd of Hereford cattle (Figure 1) was the result of a mutation and not a union of similar homozygous recessive genes? *Concepts* Nos. 9, 11, and 18.

4. Let us suppose that Farmer Smith lives near by, and has watched with interest the first calf that was born without horns. He watched the calf as it grew to maturity and was mated with horned cattle. All of the offspring were hornless. Farmer Smith bought one of these

offspring such as is shown in Figure 1. It was a bull. He used it as the sire for his herd of horned cattle. Farmer Smith had a desire to get all *hornless* offspring such as he had observed in the herd of his neighbor. Actually Mr. Smith got all *horned* offspring.

Show the expected heredity of the cross, including the possible genotypes and phenotypes of parents and offspring. Hornless (H) is dominant over horned (h) cattle. *Reference:* V, 539–43.

5. In connection with your answer just above, it should be remembered that each parent has many eggs or sperms and that any one of the sperms may unite with any one of the eggs in fertilization. With this information, explain how it happened that Mr. Smith got all horned offspring in his herd.

Section 3. Genes Are the Parts of Chromosomes that Bear Hereditary Traits, Under Favorable Environmental Conditions

You will recall that every plant and animal is made of cells, and in the living protoplasm of every cell is a nucleus.

Your may set up a demonstration by taking the thin transparent skin from the inner concave layer of an onion bulb and examining it under the compound microscope. It may be mounted in water or better still in a drop of iodine solution. With the use of the microscope you will be able to see a tiny dark spot in each cell. This spot is the nucleus of the cell.

1. Make a drawing and label the parts of the microscopic observation.

2. The nucleus of each cell of every plant or animal has chromosomes. You will not be able to see these chromosomes unless you have an especially prepared microscope slide. What part do chromosomes play in heredity? *Concept* No. 4.

3. Think of some dog you have seen and recall the shape and size of its ears, color markings, and other characteristics that go to make a dog. The dog is composed of hundreds of such traits, yet there are only twelve chromosomes in the nucleus of each cell of the dog. How is it possible for the dog to have so many hereditary traits when there are only twelve different kinds of chromosomes? *Concepts* Nos. 5 and 7.

4. A calf was born from Hereford parents. The calf had more red and less white hair than its parents had or other Hereford cattle usually have. The lack of the usual white markings disqualified him from being registered as a pure bred Hereford. It has been suggested that the unusual amount of red was shown because the mother had looked at a red barn just before the calf was born. Explain why this suggestion is wrong. *Concepts Nos. 18 and 21.*

How may we account for the combination of colors that developed in the calf? *Concept* No. 15.

FIG. 1. This chart is a suggestion for one involving more parts to be made by students on heavy pasteboard. The pasteboard chart is to be cut in squares and fitted together as a cross-word puzzle. Drawing by Chu Kuey.

5. During the lifetime of Ernest R. Kroeger, a Saint Louis musician, he could play from memory on the piano any one of five hundred classic compositions. When asked to write an article on how to memorize music, he explained that he did not know how he did it. After playing over a composition for a short while he had it memorized. Of course, Mr. Kroeger learned to play the piano by studying under the direction of music teachers, yet he developed musical abilities far beyond the achievements of most musicians. Explain why both heredity and environment played an important part in making it possible for Mr. Kroeger to play many compositions from memory. *Concept* No. 19.

6. The small hydrangea plant that is grown as a house plant ordinarily produces blue flowers. When grown in definitely acid soil, the flowers are red instead of blue. Did this change in flower color take place in the germplasm or somatoplasm? State the reason for your answer. *Concepts* Nos. 20 and 21.

7. Dick Cleveland is the fastest sprint swimmer in the world. In January, 1952, Cleveland set the 100 yard free style record, swimming the distance in 49.3 seconds. Cleveland, a native of Honolulu, is 22 years old, 6 feet tall, and he weighs 175 pounds. Is heredity or environment chiefly responsible for the muscular coordination and muscular development that has made it possible for this Ohio State University athlete to become perhaps the world's fastest swimmer? *Concept* No.3.

8. A big tree was sawed down. Stump sprouts grew rapidly and with larger leaves than had grown before. The old root system was still effective and supplied the stump sprouts with an abundance of water and minerals. Was the development of unusually large leaves due especially to heredity or environment? Explain the reason for your answer. *Concept* No. 20.

9. The author recalls picking some flowers off a papaw tree and marking the place were the flowers were removed. A little later leaves grew back at the same place. Was the heredity changed or was the old heredity expressed in a different way? Explain your answer. *Concepts* Nos. 20 and 21.

10. A boy is sick with tuberculosis. His mother on two occasions has been confined to a tuberculosis sanitarium. He also has a brother with a deep cough. Why would it be incorrect to say that the boy inherited tuberculosis from his mother? *Concept* No. 22.

Section 4. Pairs of Genes and Frequently Combinations of Pairs of Genes Result in Various Physical Characteristics of an Organism

Eye color is determined by heredity. The heredity of various eye colors is not fully understood. Hazel or green eyes, however, are

dominant over blue eyes. Brown eyes are dominant over any of the colors that have already been mentioned.

1. Show the genotypes and phenotypes of a family in which two brown-eyed parents have three children, two of whom are brown-eyed (B) and one of whom is blue-eyed (b). In doing this, show all of the possible combinations of the genotypes in the offspring even though all of the combinations of the genotypes would not actually have to be present in these offspring. *Concepts* Nos. 6 and 13.

2. Why may we speak of brown or blue eyes as a heritable unit trait? *Concept* No. 14.

3. A father has brown hair. The mother and daughter each have red hair. The color of one's hair is a heritable unit trait. Brown hair (B) is dominant over red hair (b). Show the genotypes and phenotypes of this family with reference to color of hair. *Concepts* Nos. 10 and 11.

4. Whether it is color of hair or some character that is more vital to success of an organism, such a trait is the physical expression of genes. Is it possible to change the genes? *Concept* No. 21.

5. When a gardener saves seeds from only the plants that produce choice tomatoes and plants them for the coming season, he may eliminate some undesirable genes and allow other genes to lead to the development of additional choice tomatoes. This method is called *artificial selection*. In artificial selection of tomatoes, explain why the gardener did or did not change the structure of genes. *Concept* No. 23.

6. A farmer wants to increase the number of pounds of butterfat that is produced annually from his herd of cows. In addition to supplying proper feed and other living conditions, he must improve the heredity of his herd. The farmer improves his herd by mating his cows with a registered bull that is known to produce cows that have a high yield of butterfat. Why may we say that the dairy farmer is not really creating any new germplasm? *Concepts* Nos. 21 and 23.

7. In human beings the functions of heredity work in the same manner as they do in farm animals. Most of us are agreed that a more intelligent population is desirable. Usually the people who are the most intelligent have the most education or have been most successful in business or industry. In the last census of the people of the United States, it is noted that those who had the most education had the smallest number of children in their families. What will be the effect of the present trend in birth rates upon the intelligence of our nation? *Concept* No. 23.

8. Why do you think the most capable people of our population should take a favorable attitude towards larger families? *Concept* No. 23.

9. Have parents any right to have more children than they can support? *Concept* No. 23.

Section 5. More Examples of Pairs of Genes Blending

Right-handedness and left-handedness are hereditary. A naturally left-handed child is sometimes taught by his parents to be right-handed. Sometimes they do not know that the child is naturally left-handed. To train a naturally left-handed child to write with his right hand may disturb the nervous system to the extent that he will stutter.

1. Mr. and Mrs. Fisher, who are both right-handed, have three children. Two of the children are left-handed and one of them is right-handed. Show the genotypes of this family with regard to right-handedness (R) and left-handedness (r). Either of these characteristics is a heritable unit trait. *Concept* No. 14.

2. Both Mr. and Mrs. Cianelli are left-handed. They have four children, all of whom are left-handed. Show the genotypes of the family with reference to left-handedness. *Concept* No. 9.

3. Mr. and Mrs. Hook taught their son, Robert, to write with his right hand. Bob's parents are left-handed. Bob stutters when he gets excited. Show the genotypes of this family for right or left-handedness. Explain why it would have been better for the son to have been taught to write with his left hand. *Concept* No. 9.

4. Jack MacKenzie, a farmer in Ohio, bought a herd of Shorthorn cattle from Canada. All of these cattle were white. Later Mr. MacKenzie bought a Shorthorn bull that was red. All of the ancestors of the bull had been red for many generations. The bull and the white cows were mated. Before we began the study of heredity we may have expected the offspring to have a mixture of red and white hair. That is exactly what happened in Mr. MacKenzie's herd. In the offspring the red was interspersed with white. Such a combination of colors is called roan. The roan offspring are examples of partial dominance or blending. Explain what is meant by blending. *Concept* No. 12.

5. Show the genotypes and phenotypes of the animals in problem 4. The gene for red (R) and the gene for white (r) are alleles. *Concept* No. 16.

6. Let us suppose that the offspring (F_1 generation) in problem 4 were bred with one another. Such breeding of close relatives is called *inbreeding*. Usually inbreeding is not practiced, but with superior stock it may result in superior offspring. Show the genotypes and phenotypes of the F_1 and F_2 generations that we have discussed in this problem. (F stands for the word filial and means son or daughter. F_1 is for the first generation of offspring; F_2 is for the second generation of offspring.) *Concept* No. 13.

Section 6. Two Pairs of Genes, Considered at One time

We have discussed variations in color of cattle (Section 5) and also the horned and hornless characters in cattle (Section 2)—at different times. Obviously, these and countless other traits occur all at once. It would be too difficult, however, to study all at once these and many other characters that go to make an organism. This is especially true when we realize that numerous characters, such as intelligence in man, are each the result of a combination of many pairs of genes. Let us see how complicated the problem becomes when just two sets of characters are studied at one time.

1. When you go horse-back riding, it will be interesting to recall that the trotting (T) gait is dominant over the pacing (t) gait. Black hair (B) is dominant over chestnut brown hair (b). A homozygous blackhaired trotter, a stallion (male), is crossed with several chestnut brown mares (females) that are pacers. Show the genotypes of these-parent horses. *Concept* No. 8.

2. In your study of reproduction it was agreed that a sperm or egg has only half of the number of chromosomes (N number) that each body cell has. In regard to the characters that are given in the above problem, show the kind of sperms that the stallion has and the kind of eggs that any one of the mares has. *Concept* No. 4.

3. Show the genotypes of the F_1 generation when the horses that are mentioned above are mated. *Concepts* Nos. 8 and 13.

4. What will be the phenotype of the F_1 generation? *Concept* No. 13.

5. How may the animals in the F_1 generation be classified with reference to their genotypes which we know to be present? *Concept* No. 10.

6. Show the four different kinds of sperms and four different kinds of eggs that may be present in any animal of this F_1 generation. *Reference* A, 597–9; D, 456–7; or G, 544–6.

7. The horses of the F_1 generation in the above problems are inbred. Show the genotypes of this cross with the use of checkerboard squares. See the references that are given in the problem just above.

8. In each block of the checkerboard write the name of the phenotype. *Concept* No. 13.

9. In the checkerboard squares, the traits (characters that show) are combined in different ways. Count the number of examples of each combination of similar traits and write the numbers in the form of a ratio. See references given in problem 6.

10. Your answer for problem 9 is the expected ratio for the F_2 generation. The actual results may be somewhat different, because they will be determined by the chance union of sperms and eggs.

What would have been the expected ratio in the F_2 generation if you had only one set of contrasting traits? (See your answer for Section 5, Problem 6.)

11. Make another set of 16 checkerboard squares. Write (preferably with India ink) the genes that are contained in each of the four different kinds of sperms on separate faces of pennies. This will require the four sides of two pennies. Write the genes that are in each of the four different kinds of eggs on each of the four sides of two nickels. Juggle the four coins and let them fall. Take your reading of each nickel and penny that are closest to each other and copy the four letters in a square of the checkerboard. Next, copy the reading of the other two coins. Continue this process until all sixteen squares are filled. From the information in this checkerboard determine and count the phenotypes of each kind. These numbers form a ratio that is based on chance. *Reference* A, 600.

12. The laws of chance are reliable when a large enough number of chances are taken. In class, add together the phenotypes of each kind that was obtained by all the students who worked problem 11. Divide each of the total numbers of like phenotypes by the number of students participating. By using this larger number of examples, does the actual ratio more nearly approach the expected ratio of 9:3:3:1?

Section 7. Genes Usually Are Not Changed by the Environment

1. A mother is an excellent typist. Her daughter takes a beginning course in high school. During the early part of the course will the daughter be able to type perhaps a hundred words per minute? *Concept* No. 21.

2. Explain why such skills as speed and accuracy in typing may or may not be passed on from parent to offspring. *Concepts* Nos. 3 and 21.

3. Today we are making our homes more sanitary. This improvement in sanitation will add to the health of people in our generation. Will the better health that we attain be transferred by means of heredity to the next generation? *Concepts* Nos. 20 and 21.

4. In the year 1800 in the United States only about one-half of the babies that were born lived until they became adults. Today with the aid of superior medical knowledge, about nine-tenths of the babies live until they reach adulthood. This means that we are keeping alive many individuals who would not have been able to survive in 1800. Many of them will marry and bear offspring. If these parents have inherent weaknesses, explain why their offspring will lower the standards of the physical well-being of the population. *Concept* No. 2.

5. Some of the parents of today who were mentioned in problem 4

have survived because of superior knowledge about common childhood diseases. How do you think their offspring will affect the physical well-being of the population? *Concept* No. 19.

6. On the back part of the top of one's head there is usually a single whorl or crown of hair. The direction of whorl of hair is a heritable unit trait. Notice how many of your classmates have a hair whorl that goes in a clockwise direction and how many have a hair whorl that goes in a counter-clockwise direction. If both types of hair whorl are not found, it will be necessary for someone to check a larger group of students. Which type of hair whorl occurs more often? Which direction of whorl is dominant and which is recessive? *Concept* No. 11.

7. Let us suppose that Mr. Don Smith and his wife each have a counter-clockwise whorl of hair. For many years both of them part their hair on the left instead of the right side of the head where it parts more naturally. They have five children. Show the genotypes and the phenotypes of the parents and offspring with respect to hair whorl. Use a capital letter (R) to represent the dominant gene and a small letter (r) to represent the recessive gene. *Concepts* Nos. 13 and 21.

8. Mr. and Mrs. Gary Griffith each had a clockwise hair whorl. They also have five children, three of whom have a clockwise hair whorl and two of whom have a counter-clockwise hair whorl. Show the genotypes that would make possible the traits in this family with respect to the direction of hair whorl. What are the phenotypes of the family? *Concept* No. 11.

Section 8. The Elimination of Undesirable Genes Will Improve the Species

1. In a family there are three children, two of whom are normal and capable children, but one of whom is feeble-minded. Both parents are quite normal people. Feeble-mindedness is a heritable unit trait. It is recessive (f) to the normal condition (F). Write the genotypes of the parents and the feeble-minded child. *Concept* No. 11.

2. What are the possible genotypes of the two normal children in the above problem? Can we tell by observing these two children the exact genotypes that are present in them? *Concept* No. 11.

3. Explain the reason for your answer to problem 2. *Concept* No. 11.

4. Modern society justifies its protection of mentally weak people such as the feeble-minded or criminally insane, and commonly places them in state institutions. Some of these mentally weak, however, find their way into free society where they bear offspring. Explain why such practice is detrimental to future generations. *Concepts* Nos. 2, 3, and 21; also *Reference:* G, 558-9.

5. We Americans have not effectively solved the problem of deal-

ing with the mentally sub-normal. From the following list of ways, choose the ones that you think are preferable and in each case give the reasons for your choice.

1. We should make certain that the sub-normal are kept in institutions where they will not be allowed to bear offspring.
2. We should sterilize the mentally sub-normal and when possible let them make a living for themselves in free society.
3. We should have strict immigration laws that would keep out of our country any additional sub-normal people who desire to enter the United States from foreign countries.
4. We should pass laws that would favor birth control. This sort of law would make possible the establishment of birth-contol clinics that would be in reach of people who live under poor economic conditions and at the present time are having the largest families. *Concepts* Nos. 2, 3, and 21.

Section 9. Outbreeding

In the latter half of the seventeenth century, there were two Dutchmen who settled in the state of New York. So far as we know they were not related and their descendants did not intermarry. One of these Dutchmen, Garrit Banker, was a merchant of considerable wealth. His descendants maintained high cultural and social position. Some of them became prominent; for example, one was the first speaker of the assembly. Several held high ranks in the Continental Army. Since then, they have been less prominent but have continued to maintain high social standing and respectability.

When the other Dutchman, Lorens, was a young man, he could not write his own name. Before the American Revolution, he and other members of his family were obscure. They had few opportunities for education and they acquired but little of the world's goods. They furnished numerous soldiers for the continental army, but none of them held a rank above a corporal. Following the Revolution there were more opportunities, and in the next several generations, members of this family reached positions of high social standing. A few obtained a considerable degree of public eminence.

We see a tendency for each of the two families that are mentioned above to approach a common level. The second family, perhaps with a desire to marry as well as possible brought new and stronger traits into the family. They developed highly their native capacities.

1. If we had a strong caste system in America where one social group would not intermarry with another, is it likely that these two families would have approached a common level of attainment? Explain your answer. *Concepts* Nos. 2, 3, and 21.

2. Were most of the poorer hereditary factors of the Lorens family

eliminated in the so-called American melting pot or were they partly hidden in the offspring that became more outstanding? *Concept* No. 11.

3. The Lorens family is an example of outbreeding. Study again carefully all of the information that is given about the family. From this example write a definition of outbreeding.

4. Let us think of a community in which a family name is common. The family includes brothers and sisters, aunts and uncles, and cousins. In the last century this family has had several cases of feeble-mindedness. Why would a member of the family have a better chance of the trait not being expressed if he would marry an unrelated individual rather than a cousin? *Concepts* Nos. 10 and 11.

5. In an example of outbreeding, why is it likely by such practice that hidden genes for feeble-mindedness would be increased in the offspring and perhaps show again in future generations? *Concepts* Nos. 10 and 11; *Reference:* V, 558–9.

6. Let us suppose in the family in problem 4 that second cousins married and that they had a feeble-minded offspring. It is unfortunate that such an undesirable trait should be expressed. Whenever such a trait was shown in the family, it should have been eliminated from all future generations. By what ways could the trait have been eliminated from the species? *Concept* No. 23.

7. America needs the greatest statesmen, the greatest scientists, and the greatest artists in the world. Below are a list of ways that are suggested for achieving this greatness in coming generations. Choose the one that you believe will best accomplish this aim and *give your reasons* for the choice.

1. One should be encouraged to marry another with whom he has no known relationship.
2. People of superior social and intellectual accomplishments should marry and bear offspring.
3. All foreigners should be kept out of the United States.
4. Only perfect physical specimens should be encouraged to marry and bear offspring.
5. A pregnant mother should read autobiographies of famous Americans. The mental impressions that will be gained by such reading will be transferred to the offspring. (Review problems 1, 2, 3, 4, and 5 of this section.)

Section 10. Inbreeding

Timothy Edwards was pastor of a Connecticut church for 59 years. He had been an outstanding student at Harvard University. He had eleven children. The only son was Jonathan Edwards who became

one of the world's great intellects, pre-eminent as a theologian and president of Princeton University.

Jonathan Edwards had a long line of famous descendants. Let us mention only the ones who became college presidents, up to the year 1900. Jonathan Edwards, Jr., was president of Union College; Timothy Dwight, president of Yale; Theodore Dwight Woolsey, for 25 years president of Yale; Timothy Dwight, II, was also president of Yale; and Edward Gates, President of Amherst College.

1. Why is it likely that Jonathan Edwards or his father, Timothy Edwards, was not the originator of any of the excellent qualities of his descendants? *Concepts* Nos. 3 and 21.

2. Did you ever hear this statement: How could such an eminent man have committed a crime? In the brilliant Edwards family we have that kind of problem. One member achieved the pre-eminent position of vice president of the United States—yet that same man, Aaron Burr, performed acts of treachery against his own government. Without the authority of his own government, he attempted to conspire against the neighboring government of Mexico. Then the unfortunate pistol duel occurred in which he killed Alexander Hamilton. Do you think that it would be possible for such an outstanding family to have carried the undesirable hereditary factors that seemed to be expressed in Aaron Burr? *Concept* No. 11.

3. In this remarkable family, Timothy Edwards was the first member whom we discussed. He was born in the latter part of the seventeenth century in Hartford, Connecticut. It is of exceeding interest to note that his father, Richard Edwards, was a lawyer of high repute, and his mother, Elizabeth Tuttle, was of extreme intellectual vigor and at least remotely descended from English royalty. Elizabeth Tuttle, nevertheless, was lacking in moral qualities. The undesirable trait was in the Tuttle family, for one of Elizabeth's sisters murdered her own son and a brother murdered his own sister. Richard Edwards obtained a divorce from Elizabeth Tuttle on the grounds of immorality. With this information, check the accuracy of your answer for problem No. 2 above.

4. Richard Edwards later re-married and had six children by Mary Talcott, a woman somewhat below average in ability. None of their descendants were outstanding. In this example of outbreeding, were the superior traits of Richard Edwards emphasized or diluted in the offspring?

5. When we consider the descendants of Richard Edwards and Elizabeth Tuttle, as a whole, were they chiefly of superior or inferior quality? (See the first two paragraphs of this section.)

6. America needs capable leaders. In order that we may have

outstanding leaders, explain why it is desirable for people of superior intellect, such as the ancestry of Jonathan Edwards, to marry one another rather than for each of them to marry average people. (See problems 4 and 5 in this section.)

Twenty-six out of 46 men in the Hall of Fame had close eminent relatives. This is an example of *inbreeding*. With the use of the example and also a dictionary, explain in your own words what is meant by inbreeding.

Section 11. Natural Selection, Artificial Selection, and Controlled Breeding

In the fields and woods of many parts of the nation, one may occasionally find a wild crab-apple tree. The fruit is about an inch in diameter and has a sour taste. Perhaps crab-apples are something like the original apples that grew in Europe along the Caspian Sea.

During this season of the year, you may go to the corner grocery and buy for about a dime a large sweet juicy red Delicious or Golden Delicious apple.

The pleasant taste of a Delicious apple is indeed a far cry from the biting sour taste of a crab-apple. If these two varieties of apple trees were to grow side by side in a wild area, it is a good possibility that wild animals would eat in greater number the larger fruits. More of the sour inconspicuous crab-apple trees would increase in number. The Delicious apples, on the other hand, would gradually die out. The survival of one variety and the gradual disappearance of the other is an example of *natural selection*.

1. Natural selection may apply to either plants or animals. With the help of the example that is given above, explain in your own words what is meant by natural selection. *Reference:* V, 569.

2. Before the Delicious apples of today could develop, early forms of apples had to undergo many changes. What name is given to such a change when it becomes a permanent part of an organism and may be passed on from one generation to the next? *Concept* No. 18.

3. One finds an unusually large apple. He plants the seeds with the hope that they will grow into trees that will raise especially big apples. What name is given to such practice? (See Section 4, Problem 5.)

4. The plant breeder does detailed work. He may cover some of the flowers of an apple tree so that self-pollination only can take place. Before covering the flower he may pinch off the stamens and cross pollinate it by hand. This is an example of *controlled breeding*. Turn back to Section 4, Problem 6. That is an example of controlled breeding in animals. Section 4, Problem 5 is an example of artificial selection.

With the use of these examples, write an explanation that will show the difference between controlled breeding and artificial selection.

Section 12. Color Blindness Is a Sex Linked Character

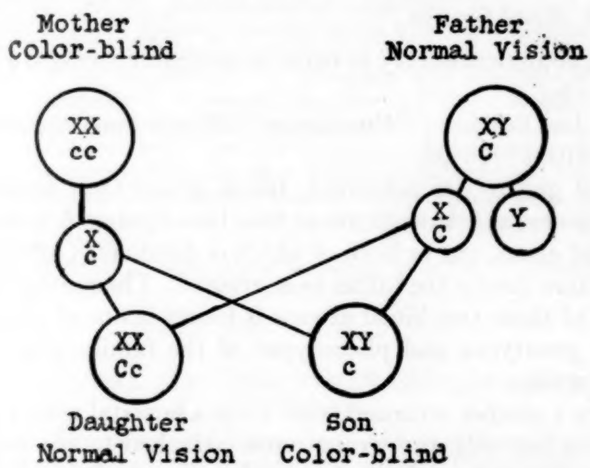
The sex of people is determined by one pair of chromosomes. In the female this pair of chromosomes (XX) are alike. In the male one of the pair (XY) is odd shaped and smaller than the other.

1. A family consists of the parents together with a son and a daughter. Show the genotypes of the family with respect to sex and include the sperms and eggs of the parents. *Reference:* S, 461–8.

2. The most obvious kind of color blindness is the lack of ability to tell the difference between red and green colors. This condition is due to a single pair of genes and is recessive (c) to normal vision (C).

The genes that determine color blindness are each a part of a chromosome that governs many other traits. Explain why this is a usual or an unusual condition. (See your answer for Section 3, Problem 3; *Concept* No. 17.)

3. It happens that the genes for red-green color blindness are located in the sex chromosomes, and because of this are said to be *sex-linked.* The following examples will show that we get some unexpected results, because the Y chromosome of the male is smaller and does not carry many genes for traits other than sex.



Study carefully this problem. Explain why all of the sons will inherit color blindness from the mother, yet all of the daughters will have normal vision. *Reference:* S, 492–3; 511.

4. In another family both parents have normal vision. They have one daughter with normal vision and one son who is color blind. Show the genotypes of this family with respect to sex and color blindness.

The mother is heterozygous for color blindness. *Reference:* S, 492–3; 511.

Section 13. Bald-headedness is a Sex Influenced Character

Baldness in man may be due to disease, but usually is the result of heredity. All of the common patterns of baldness are due to heredity. Baldness is not sex linked but is influenced by sex. It is dominant in man and recessive in woman. In other words, the presence of one gene for baldness (B) and one for the presence of hair (b) would cause a man to be bald. Since the same kind of gene (B) is recessive in woman, two factors (BB) would have to be present before baldness would occur in a woman.

According to the above information, decide which of the following statements are true. Copy all of the statements that you find to be correct.

1. Most baldness is due to heredity.
2. All of the common patterns of baldness are due to heredity.
3. Occasionally, women will be bald.
4. The reason most men are bald is that they did not start to use hair tonic early enough in life.
5. When neither of the parents are bald, about half of ther sons might possibly develop baldness because of heredity.

Section 14. Blood Groups

Read in your local library or listen to an oral report and a discussion of this article:

Porter, Dr. Edith L., "Pregnancy," *Hygeia* magazine, December, 1946, pp. 910–1; 926–30.

1. Blood groups are inherited. Blood group O is determined by recessive genes (aa). In contrast to this, blood group A is dertermined by a pair of genes, one or both of which is dominant (AA or Aa).

In a certain family the father is in group O. The mother is in group A. Either of these two blood groups is found in one of their children. Show the genotypes and phenotypes of the family with respect to blood groupings.

2. When a mother returned home from a hospital with a new baby, she found a tag with the wrong name attached to the baby. Blood types were determined. The baby was in group A. Each of the parents was in group O.

Show the genotypes of the parents and also of the baby. Explain with the aid of your answer for Problem 1 why we are certain that the parents had the wrong baby.

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MATHEMATICS INSTITUTE

The University of Houston, Houston, Texas, will hold its Second Mathematics Institute July 28–31, 1952. This institute is being sponsored by the College of Education, the Mathematics Department of the College of Arts and Sciences, and the College of Business Administration.

Specialists in the field of mathematics teaching who will participate in the institute program are: Dr. Edwina Deans, Elementary Supervisor, Arlington, Virginia; Dr. Herbert F. Spitzer, Principal of the University Elementary School and Associate Professor of Education, University of Iowa; and Dr. John R. Mayor, Chairman of the Department of Education and Associate Professor of Mathematics, University of Wisconsin. Mr. Martin Wright, Associate Professor of Mathematics, University of Houston, will address one of the general sessions. A Mathematics Laboratory for teachers of junior and senior high school mathematics will be directed by Miss Ida May Bernhard, Supervisor, College Laboratory School, Southwest Texas State Teachers College, San Marcos, Texas.

All meetings will be held in air-conditioned rooms; residence can be secured in air-conditioned dormitories.

For further information, write Joyce Benbrook, Box 554, University of Houston, Houston 4, Texas.

EDUCATIONAL AIDS FOR POWER SUPPLIER RURAL PROGRAMS

A 14-page booklet describing Educational Aids for Power Supplier Rural Programs is available from the Westinghouse Electric Corporation. This catalog lists free and low-cost materials that can be used by 4-H club members and leaders and vocational agriculture classes in furthering power supplier cooperation with rural youth programs.

Illustrated and described in detail are handbooks, charts, leaflets, instruction manuals, and fact folders covering all phases of electric living on the farm and in the home. Several sound movies that can be borrowed are outlined, and an order blank is enclosed for convenience in requesting materials.

For a copy of *Educational Aids for Power Supplier Rural Programs* (B-5450), write School Service, Department T, Westinghouse Electric Corporation, Box 1017, Pittsburgh 30, Pa.

PHOTOGRAPHY AS A TEACHING TOOL AND STUDENT ACTIVITY IN GENERAL SCIENCE

HERBERT P. McCONNELL
Miami University, Oxford, Ohio

Through a practical approach to the science of photography the general science teacher has an excellent means for enriching his teaching with materials of his own personal experience. This same practical approach to photography is easily resolved into a most interesting and worthwhile unit study for students of general science. Teachers in general agree that a major objective of education is to help the child understand and interpret his environment. Science teachers realize that science, in a broad sense, is a study of the environment and that they have an important role to perform in the interpretation of the environment for the young student. Photography can be of real help.

Practically all teachers of science spend some time in travel each year and the usual procedure is to take along a camera to photograph the points of interest throughout the trip. Thus, most of us have accumulated a rather large and miscellaneous collection of pictures about our environment. Have you ever thought of your picture collection as a possible teaching tool for general science? Look over your old prints, negatives and kodachromes and see how easily many of these may be sorted into scientific categories illustrative of units in general science. A list of these categories will include subjects such as clouds, flowers, rock formations, rivers, lakes, mountains, water supply, animals, trees, plants, conservation, hydro-electric plants, mining, industrial plants, transportation, national parks, bridges, engines, power, electricity and many others. To be more specific, let us imagine that you have visited Norris Dam near Knoxville, Tennessee and have taken a number of pictures of scientific value. These pictures can be used to advantage to help illustrate units on power, conservation and other related areas. The teacher will be able to present this material in an effective manner because these pictures represent a part of his personal experience background.

As you examine your collection of pictures you may wonder about the best method of showing them to your classes. This problem may be solved with a minimum of expense. The kodachromes or other color transparencies may be projected in a 2″ by 2″ slide projector. Portions of large negatives may be printed on 2″ by 2″ lantern slide plates or on standard size lantern slide plates. A 35 mm. negative film may be printed on positive film and projected in a film strip projector. If the teacher prefers not to make transparent positives he may still show his regular prints with an opaque projector.

As one takes inventory of his pictures and begins to organize a library of these materials, he naturally makes plans for improving and increasing his library. Future trips are planned so as to include opportunities for taking pictures of scientific interest. Students are encouraged to prepare charts and diagrams which may be photographed for making slides and to bring in pictures from home to be studied and evaluated as teaching materials. The best material may be copied on slides and added to the library.

As the general science teacher begins to enrich his teaching with practical photography, he will see the need for a simple photography unit in his general science course. Since pictures occupy such an important place in educational procedures and in the affairs of everyday living, and since picture taking is an activity enjoyed by most families, the teacher should not hesitate to include such a unit in his course. This unit can be very interesting, instructive and practical.

Recently the writer was privileged to observe a ninth grade general science class* as they set about to learn the fundamentals of picture making. The result was that every student in the class of thirty-eight had actual experience in picture taking, developing and printing. Emphasis was on the sound principle of learning by doing. The unit began with a discussion of photography as a means of keeping a record of personal exepriences and its value in the study of the environment. Of immediate interest to this group was the fact that in the near future they would be taking a trip to the national capital and would like to know how to make a good picture record of the experience. In order that the students might understand the principle of the camera, a lesson on light and lenses was arranged. This lesson followed the usual pattern for ninth grade science with emphasis on image formation by convex lenses. Students handled lenses and learned about the inverted image, focal length and sharpness of focus. After this lesson they were ready to study the construction and operation of the camera. They examined a pin hole camera and saw how a faint inverted image is formed on the ground glass and had evidence that light travels in straight lines. Next, a convex lens was substituted for the pin hole and they observed the more brilliant image as more light was focused on the ground glass. A large box camera was disassembled and the various parts were studied as to construction and function. Other types of cameras were discussed as students asked questions about their own cameras. The camera film was discussed as a means of recording the image formed by the lens. The next lesson was built around the general topic of picture taking. A discussion of techniques was held and students learned the basic rules of proper exposure for various subjects and lighting conditions. At

* The class observed was taught by Mr. Fred Fox at McGuffey High School, Miami University, Oxford, Ohio.

this time picture composition was studied by showing a variety of prints in the opaque projector.

Now the day for the picture taking field trip had arrived. In the class of thirty-eight students, twenty brought cameras and film from home to use on the trip. The trip was made on a sunny afternoon and consisted of a two hour tour of the school campus, a building construction area and a wooded area along a creek of geological interest. Students had an opportunity to photograph a variety of subjects.

The exposed films were developed entirely by the students in the class. Following a teacher demonstration of tray developing techniques the students practiced with old films and trays containing water only. They were then assigned to positions in a small darkroom and developed their own films. Three students worked together at a position and six groups were able to work at one time. Thus half the class was able to develop films at the same time. Each developing position included trays of developer, water and fixing solution. Darkroom lamps were arranged for the convenience of the groups. Prepared developer was used. Results were good and many excellent negatives were produced.

While the negatives were drying a teacher demonstration outlined the proper procedures for making prints. With reasonable care in handling the printing paper, the regular classroom with shades drawn can be used as the printing darkroom. In this particular study, six developing positions were arranged and each pair of students was provided with a simple printing frame. The frame consisted of a block of wood measuring about 4" by 5" by 1" and a piece of glass to fit the block. To load the frame the negative and paper are placed between the block and glass plate. The unit is held together by rubber bands or hand pressure. Exposure was made in a nearby room using light from windows or an incandescent lamp. Six students were assigned to each developing position and the entire class was able to work at printing at the same time.

After the prints were dry, several were shown to the class in the opaque projector and a discussion relative to evaluation of the unit resulted. Students helped plan the evaluation procedure. One of these procedures, a practical test, was to select ten pictures, each with an obvious defect and to place these around the room so that they might be studied individually. As the students studied these prints they indicated on test sheets the nature of the defect, how it may have been caused and how to prevent it. A written objective test covering scientific principles involved in the unit was also given. Students were especially interested in taking some additional pictures to show that they had learned how to correct the errors made in the first film. Accordingly, each student took pictures of two assigned subjects, de-

veloped his film and made prints for evaluation by the instructor.

Needless to say the students were very enthusiastic and cooperative throughout the unit activity. Soon after the unit was completed two students set up a small photography laboratory at home and began working with photography as a hobby. Another student assumed the duties of photographer for the school paper. Throughout the unit the emphasis was on the practical aspect of picture making rather than on the theoretical. Much detail was left to be covered in later courses in chemistry and physics.

When approached in the simple and interesting manner described above the science of photography can contribute much to the general science program; it can serve as an effective tool for the teacher and also become an integral part of the general science course.

PROBLEM DEPARTMENT

Conducted by G. H. Jamison
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed, Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

Late Solutions

2275. *Elizabeth Bolley, Lakemont, N. Y.*

2283. *Roy A. Broman, Mishawaka, Ind.*

2283, 6. *James F. Gray, Kirkwood, Mo.*

2285. *Robert Bonic, Los Angeles.*

2265. *Leon Bankoff, Los Angeles.*

2287. *Proposed by S. Zucchi, Kirksville, Mo.*

Eight players attempt to arrange a card tournament with two players playing against two players. What is the maximum number of games to be played, with no two games having the same opponents.

Solution by Leon Bankoff, Los Angeles, Calif.

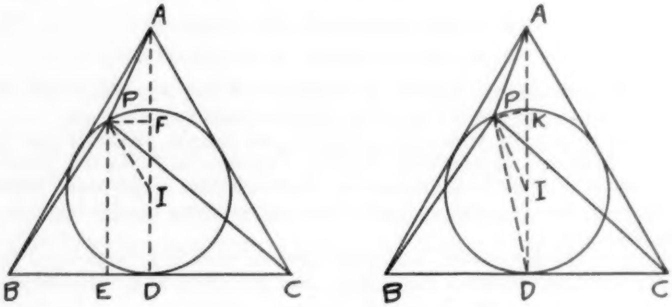
Four players may be chosen from eight in ${}_8C_4$ different ways. For each combination of four thus selected, each player may have as opponents the other three taken two at a time. Whereupon the maximum number of games to be played is

$${}_8C_4 \cdot {}_3C_2 = \left(\frac{8\cdot 7\cdot 6\cdot 5}{1\cdot 2\cdot 3\cdot 4}\right)\left(\frac{3\cdot 2}{1\cdot 2}\right) = 210.$$

Solutions were also offered by: C. W. Trigg, Los Angeles City College; Richard H. Bates, Milford, N. Y.; Hugo Brandt, Chicago; R. L. Moenter, Fremont, Nebr.

2288. *Proposed by C. W. Trigg, Los Angeles City College.*

ABC is an equilateral triangle, and P is any point on the circumference of the incircle. Using the theorems of high school geometry prove that $(PA)^2+(PB)^2+(PC)^2$ is a constant.



Solution by the Proposer

Method I. Let AD be the altitude from the vertex nearest P. This altitude will pass through I, the center of the incircle whose radius is r. Let E and F be the orthogonal projections of P on BC and AD, respectively. Then $ID=IP=r$, $PF=ED$, $(IF)^2+(PF)^2=r^2$, $IA=IB=IC=2r$, $PE=FD=IF+r$, $AF=2r-IF$, and $BD=DC=r\sqrt{3}$. It follows that $(PA)^2+(PB)^2+(PC)^2=(AF)^2+(PF)^2+(PE)^2+(BE)^2+(PE)^2+(EC)^2=(2r-IF)^2+(PF)^2+2\quad(IF+r)^2+(r\sqrt{3}-ED)^2+(r/3+ED)^2=12r^2+3(IF)^2+(PF)^2+2(ed)^2=15r^2$, a constant.

Method II. Let A be the nearest vertex to P, and let the altitude AD, which passes through the incenter I, cut the incircle at K. Then $AK=KI=ID=r$, the inradius. Also, $BD=DC=r\sqrt{3}$. In the triangle PBC, $(PB)^2+(PC)^2=2(PD)^2+2(r\sqrt{3})^2$. In the triangle PKD, $(PD)^2+(PK)^2=(2r)^2$. In the triangle PIA, $r^2+(PA)^2=2(PK)^2+2r^2$. Eliminating PK and PD from the three equations, we have $(PA)^2+(PB)^2+(PC)^2=15r^2$, a constant.

Solutions were also offered by: Hugo Brandt, Chicago; Leon Bankoff, Los Angeles; Mr. and Mrs. Walter R. Warne, Minneapolis.

2289. *Proposed by W. R. Warne, Alton, Ill.*

Show that for the pair of equations which follow there are no real or complex values of x and y satisfying both:

$$yx^3+(3y+1-y^3)x+y=$$

and

$$x^2-y^2+3=0.$$

Solution by Aaron Buchman, Buffalo, New York

It is easily shown that the first of the given equations is equivalent to

$$xy(x^2-y^2+3)+x+y=0. \tag{1}$$

Substitute the second given equation in (1) and simplify.
Then

$$x=-y. \tag{2}$$

But from the second given equation it follows that

$$x=\pm\sqrt{y^2-3}. \tag{3}$$

Then from (2) and (3) there follows the ***impossible*** relation,

$$y^2=y^2-3. \tag{5}$$

From (5) it follows that the given equations are inconsistent, and therefore have no real or complex common solution.

Note: If $f(x, y)=0$ and $g(x, y)=0$ are inconsistent, then it is evident that $f(x, y)=0$ and $h(x, y)f(x, y)+g(x, y)=0$ are also inconsistent.

Solutions were also offered by: Leon Bankoff, Los Angeles; C. W. Trigg, Los Angeles City College, Los Angeles; Richard H. Bates, Milford, N. Y.; J. A. Racheff, Lemay, Mo.; R. L. Moenter, Fremont, Nebr.; Hugo Brandt, Chicago.

2290. *Proposed by C. W. Trigg, Los Angeles City College.*

Confirm the following properties of the third row $(1, 3, 6, 10, \cdots)$ of the Pascal triangle.

1. Each element is a triangular number.
2. The nth element is the sum of the first n elements of the second row.
3. The sum of two consecutive elements is a square number.
4. The sum of the first element and eight times any other element is a square number.
5. The difference of the squares of two consecutive elements is a cube.
6. Twice the nth element added to the $(n+1)$th element of the second row yields asquare number.

Solution by Richard H. Bates, Milford, N. Y.

1. A triangular number is one, which by definition, has the form

$$\frac{n}{2}(n+1)$$

for all positive integral values of n. But since the nth term of the 2nd row is n, and the nth term of the third row is $n/2\ (n+1)$, each element is a triangular number.

2. Since the sum of the first n elements of the second row is the sum of the first n integers which is $n/2\ (n+1)$ the second property is confirmed.
3. The nth element is $1/2\cdot(n)\ (n+1)$ and the $(n+1)$th element is $1/2\cdot(n+1)\ (n+2)$ whose sum is n^2+2n+1—a square number and hence the 3rd property.
4. The sum of the first element, 1, and 8 times the nth element, $1/2\cdot(n+1)$ is $1+4n\ (n+1)=4n^2+4n+1$ which is a square number. Thus confirming the 4th property.
5. The difference of the squares of the nth and $(n+1)$th elements:

$$[1/2\cdot(n+1)(n+2)]^2-[1/2\cdot n(n+1)]^2=n^3+3n^2+3n+1$$

which is a cube and proves property 5.

6. Twice the nth element, $n(n+1)$ added to the $(n+1)$th element of the second row, $(n+1)$:

$$(n^2+n)+(n+1)=n^2+2n+1$$

which is a square number, and hence the last property.

Solutions were also offered by: Leon Bankoff, Los Angeles; Hugo Black, Chicago; J. H. Means, Austin, Texas; R. L. Moenter, Fremont, Nebr.; and also the proposer.

2291. *Proposed by Charles McCracken, Jr., Univ. of Cincinnati.*

Show that a number of the form $9n+5$ cannot be a perfect cube.

Solution by R. L. Moenter, Midland College, Fremont, Nebr.

Every integer is of the form $3n-1$, $3n$ or $3n+1$.

$$\begin{aligned}(3n\pm1)^3&=27n^3\pm27n^2+9n\pm1\\&=9(3n^3\pm3n^2+n)\pm1\\(3n)^3&=27n^3\\&=9(3n^3).\end{aligned}$$

The first cube is of the form $9n\pm1$, the second cube is of the form $9n$.
Hence every cube is of one of the forms: $9n\pm1$, $9n$.
Therefore a number of the form $9n+5$ cannot be a perfect cube.
Solutions were also offered by: James F. Gray, Kirkwood, Mo.; Leon Bankoff, Los Angeles; Roy Wild, Moscow, Idaho; Aaron Buchman, Buffalo; C. W. Trigg, Los Angeles City College; and the proposer; Hugo Brandt, Chicago; Richard H. Bates, Milford, N. Y.

2292. *Proposed by Hugo Brandt, Chicago.*

If 1, 2, 3, 10 are the first four terms of an algebraic sequence, find a formula for the general (A_n) term.

Solution by C. W. Trigg, Los Angeles City College

Method I. From the array,

$$\begin{array}{ccccccc}1&&&&\\&1&&&\\2&&0&&\\&1&&6,\\3&&6&&\\&7&&&\\10&&&&\end{array}$$

the leading term and the leading differences of the sequence are seen to be 1, 1, 0, 6. Therefore

$$\begin{aligned}A_n&=1+(n-1)(1)+[(n-1)(n-2)/2!](0)+[(n-1)(n-2)(n-3)/3!](6)\\&=n^3-6n^2+12n-6.\end{aligned}$$

Method II. Assume that the general term of the sequence is a polynomial of the third degree, $a+bn+cn^2+dn^3$. Then we have

$$\begin{aligned}a+\ b+\ \ c+\ \ d&=1\\a+2b+\ 4c+\ 8d&=2\\a+3b+\ 9c+27d&=3\\a+4b+16c+64d&=0\end{aligned}$$

When these equations are solved simultaneously in the conventional fashion we have $a=-6$, $b=12$, $c=-6$, $d=1$. Therefore the simplest polynomial expression for A_n is $n^3-6n+12n-6$.

However, we may assume that the general term of the series is a polynomial

of the fourth degree, $a+bn+cn^2+dn^3+en^4$, and that the fifth term of the series is any desired number k. We then have to find the solution of the set of simultaneous equations

$$a+b+c+d+e=1, \quad a+2c+4c+8d+16e=2,$$
$$a+3b+9c+27d+81e=3 \quad a+4b+16c+64d+256e=0$$

and

$$a+5b+25c+125d+625e=k.$$

The solution of these equations is $a=k-35$, $b=-(50k-1738)/24$, $c=(35k-1159)/24$, $d=-(10k-314)/24$, and $e=(k-29)/24$. Hence

$$A_n=k-35-\left[(50k-1738)n-(35k-1159)n^2+(10k-314)n^3-(k-29)n^4\right]/24.$$

It will be observed that when $k=29$, the simpler cubic form is secured.

If

$$k=-19, \quad A_n=-54+112n-76n^2+21n^3-2n^4;$$
$$k=\ \ 5, \quad A_n=-30+\ 62n-41n^2+11n^3-\ n^4;$$
$$k=\ 53, \quad A_n=\ 18-\ 38n+29n^2-\ 9n^3+\ n^4.$$

Clearly we may assume any number x of terms after the 10, and assign any desired values to these terms, thus developing polynomial expressions for A_n of degree $x+3$. Hence the problem does not have a unique solution.

Solutions were also proposed by: Marjory Winkler, Sault Ste. Marie, Mich.; Charles McCracken, Jr., Batavia, Ohio; James F. Gray, Kirkwood, Mo.; Roy Wild, Moscow, Idaho; Richard H. Bates, Milford, N. Y.; and the proposer.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

For this issue the Honor Roll appears below.

2292. *David Cantor, La Mesa, Calif.; Walter Reichel, Short Hills, N. J.*

2284. *William Wall, St. John's, Nfld., Canada; Stuart P. Godwin, Toronto, Ontario, Canada.*

2285. *Stuart Godwin, Upper Canada College.*

2281, 3, 4. *W. M. H. Grover, Upper Canada College.*

PROBLEMS FOR SOLUTION

2305. *Proposed by V. C. Bailey, Evansville, Ind.*

Show that the in-radius of the triangle formed by the feet of the altitudes of any plane triangle, ABC, is given by formula $r=2\,R\cos A\cos B\cos C$, when R is radius of circum-circle of triangle ABC.

2306. *Proposed by V. C. Bailey, Evansville, Ind.*

Find the limit as $x\to 0$ of

$$\frac{\sin(\tan x)-\tan(\sin x)}{x^7}.$$

2307. *Proposed by Hugo Brandt, Chicago.*

If a three digit number; u, unit's digit; t, ten's digit; and h, hundred's digit

equals the same number with another base, say n but with order of digits reversed find all possible cases.

2308. *Proposed by Hugo Brandt, Chicago.*

For a given parabola $y^2=2px$, P is a variable point with PQ and PS tangents. If triangle PQS is constant in area show that the locus of P is another parabola, same form, same parameter and same x-axis. P and Q are points of tangency.

2309. *Proposed by C. W. Trigg, Los Angeles City College.*

Similar triangles are constructed on the legs of a right triangle with their third vertices lying on the lines through the vertices of the acute angles of the right triangle and parallel to the bisector of the right angle. Show that the joins of these third vertices to the remote vertices of the right triangle intersect on the bisector of the right angle.

2310. *Proposed by C. W. Trigg, Los Angeles City College.*

Show that the difference in the radii of the two spheres, one equivalent in area, the other equivalent in volume, to a *prolate* ellipsoid of revolution is of the fourth order in the eccentricity of the generating ellipse.

BOOKS AND PAMPHLETS RECEIVED

SOLID GEOMETRY, by Walter W. Hart, *Author of Mathematics Textbooks, and Formerly Associate Professor of Mathematics, School of Education, University of Wisconsin;* and Veryl Schult, *Supervisor of Mathematics, Divisions I–IX, Washington, D. C.* Cloth. Pages ix+198. 13.5×20 cm. 1952. D. C. Heath and Company, 285 Columbus Avenue, Boston 16, Mass. Price $2.40.

SCIENCE FOR A BETTER WORLD, by Morris Meister, *Principal of the Bronx High School, Bronx, New York;* Ralph E. Keirstead, *Science Instructor, Bulkeley High School, Hartford, Connecticut;* and Lois M. Shoemaker, *Teacher of Biology, New Jersey State Teachers College, Trenton, N. J.* Cloth. Pages vi+778. 15×21 cm. 1952. Charles Scribner's Sons, 597 Fifth Avenue, New York 17, N. Y. Price $3.20.

SCIENCE, A STORY OF DISCOVERY AND PROGRESS, by Ira C. Davis, *University of Wisconsin;* John Burnett, *Arlington Memorial School, Arlington, Vermont; and* E. Wayne Gross, *Junior and Senior High School, and University School, Bloomington, Indiana.* Cloth. Pages xiv+562. 15×23.5 cm. 1952. Henry Holt and Company, 257 Fourth Avenue, New York 10, N. Y. Price $3.44.

TEACHING MATHEMATICS IN THE SECONDARY SCHOOL, by Lucien Blair Kinney, *Professor of Education, Stanford University;* and C. Richard Purdy, *Associate Professor of Mathematics, San Jose State College.* Cloth. Pages xvi+381. 15×23 cm. 1952. Rinehart and Company, Inc., 232 Madison Avenue, New York 16, N. Y. Price $5.00.

NOMOGRAPHY AND EMPIRICAL EQUATIONS, by Lee H. Johnson, *Tulane University.* Cloth. Pages ix+150. 14.5×23 cm. 1952. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $3.75.

CHEMICAL CALCULATIONS, AN INTRODUCTION TO THE USE OF MATHEMATICS IN CHEMISTRY, by Sidney W. Benson, *Professor of Chemistry, University of Southern California.* Cloth. Pages xi+217. 14.5×22.5 cm. 1952. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $2.95.

EVERYDAY MATHEMATICS, Revised Edition, by Harl R. Douglass, *Director, College of Education, University of Colorado;* Lucien B. Kinney, *Professor of Education, Stanford University;* and Vincent Ruble, *Jordan Junior High School, Palo Alto, California.* Cloth. Pages vii+504. 13×21 cm. 1951. Henry Holt and Company, 257 Fourth Avenue, New York 10, N. Y. Price $2.48.

ALGEBRA FOR PROBLEM SOLVING, Book 1, by Julius Freilich, *Chairman, Mathematical Department, Brooklyn Technical High School, New York;* Simon L. Berman, *Chairman, Mathematics Department, Stuyvesant High School, New York;* and Elsie Parker Johnson, *Chairman, Mathematics Department, Oak Park and River Forest High School, Illinois.* Cloth. 568 pages. 15×23 cm. 1952. Houghton Mifflin Company, 2 Park Street, Boston, Mass. Price $2.88.

THE NATURE OF NUMBER, by Roy Dubisch, *Associate Professor of Mathematics, Fresno State College.* Cloth. Pages xxxi+159. 14×21.5 cm. 1952. The Ronald Press Company, 15 East 26th Street, New York, N. Y. Price $4.00.

TODAY'S SCIENCE AND YOU, by Lynn Poole, *Producer of Johns Hopkins TV Science Review.* Cloth. 208 pages. 13.5×20.5 cm. 1952. Whittlesey House, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price $2.75.

WE ARE A FAMILY, by Inez Hogan, *Author of "Twin Lambs," "World Round," "Nappy is a Cowboy," etc.* Cloth. 93 pages. 22×25.5 cm. 1952. E. P. Dutton and Company, Inc., 300 Fourth Avenue, New York 10, N. Y. Price $2.75.

PHASE RULE AND ITS APPLICATIONS, Ninth Edition, by A. N. Campbell, *Professor of Chemistry, The University of Manitoba,* and N. O. Smith, *Associate Professor of Physical Chemistry in Fordham University.* Paper. 494 pages. 13.5×20.5 cm. 1951. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price $1.90.

FOUNDATIONS OF AERODYNAMICS OF HIGH SPEED, Edited by George F. Carrier, *Professor of Engineering, Brown University.* Paper. 286 pages. 15.5×23.5 cm. 1951. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price $1.75.

TWO NEW SCIENCES, by Galileo Galilei, Translated from the Italian and Latin into English by Henry Crew and Alfonso De Salvio, of *Northwestern University.* Paper. Pages xxi+300. 13×20.5 cm. 1914. Reissued 1952. Dover Pubilcations, Inc., 1780 Broadway, New York 19, N. Y. Price $1.50.

MATTER AND MOTION, by the Late J. Clerk Maxwell, M.A., LL.D. Edin., F.R.SS.L. and E., *Professor of Experimental Physics in the University of Cambridge.* Paper. 161 pages. 13×20.5 cm. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price $1.25.

LABORATORY EXERCISES IN GENERAL BIOLOGY, Fourth Edition, by James Watt Mavor, Ph.D., *Professor of Biology, Emeritus Union College.* Paper. Pages xiv+333. 20.5×28 cm. 1952. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $3.50.

SCIENTIFIC PERSONAL EMPLOYMENT BULLETIN. 38 pages. 20×26 cm. January 1952. Personnel Division, Office of Naval Research, Department of the Navy, Washington 25, D. C.

Weaving device allows the housewife to re-weave moth-eaten or torn garments. Tweezer-like needles catch hold of frayed threads of the patch, pushing them through to the underside of the material.

BOOK REVIEWS

British Scientists, by E. J. Holmyard, *Editor of Endeavor, Vice-President of the British Society for the History of Science.* Cloth. Pages viii+88. 12×18½ cm. 1951. First Edition, The Philosophical Library, Incorporated, New York. Price $2.75.

This book treats in a very brief manner the contributions of British investigators to the field of experimental science. The author has done other writings on the history of science especially alchemy and early chemistry.

Beginning with the works of Robert Chester who lived in the 12th century he goes on to Roger Bacon and finally comes down to modern times with Lord Rutherford who gave us a new concept of the atom and Sir Frederick Gowland Hopkins who discovered vitamins. The final chapter is devoted to British scientific societies. Here he discusses the origin and growth of the Royal Society, the Royal Institution and others.

Any teacher of Science who makes use of the historical approach will want to add this book to his personal shelf. It would be an excellent book for either the senior high school or junior college library.

Gerald Osborn
Western Michigan College of Education
Kalamazoo, Michigan

Aluminum from Mine to Sky, by June Metcalfe, *an Associate member of the American Institute of Mining and Metallurgical Engineers.* Cloth. Pages 128. 15.5×23 cm. 1947. Whittlesey House, McGraw-Hill Book Company, Incorporated, New York. Price $2.75.

The author tells in an interesting and fascinating manner the story of aluminum. Book I treats the early history of the element in a way easily understood by high school students. Since two young men of college age working independently discovered the modern method of preparing aluminum, youth is attracted to this story. The problems faced by Charles Martin Hall in the raising of funds to back his project and in later finding methods of marketing the refined aluminum are well explained.

Book II first treats the problem of mining the bauxite. Then follows the detailed story of the metallurgy. Finally the use of aluminum alloys in the manufacture of modern airplanes is graphically explained. The book is well illustrated.

Many high school librarians will want to place this book on their science shelves.

Gerald Osborn

General Education in Science, Edited by I. Bernard Cohen and Fletcher G. Watson, both of *Harvard University.* Cloth. Pages xv+217. 14×21 cm. 1952. Harvard University Press, Cambridge, Massachusetts. Price $4.00.

Following an appropriate foreword by President James B. Conant, the book is composed of a collection of fifteen papers which were originally presented before the members of a workshop in science in General Education at Harvard during the summer of 1950. The papers of the fifteen lectures are organized under the following general topics—

1. Science for the Nonscientist
2. The Philosophy of Science and the Teaching of Science
3. The History of Science and the Teaching of Science
4. The Sciences in a Technical Civilization
5. Some Problems in the Teaching of Biology
6. The Evaluation Problem

Over 50% of the lecturers were from the Harvard faculty; all of them are well recognized men in their respective fields. The first paper, *Science and the Laymen* is by René J. Dubos of Rockefeller Institute for Medical Research. Another pa-

per is entitled *What the Layman Needs to Know About Science* by the famous physicist S. A. Goudsmit of Brookhaven National Laboratory.

Teachers of Science in Junior Colleges, Colleges, and Universities should read this book. They will find presented some goals and teaching methods which are used at Harvard and other universities in the teachings of science on the general education level. Since there is a wide diversity of opinion as to what constitutes general education, the reviewer did not always find himself in agreement with the goals and methods set forth, but he did enjoy reading the book. The paper by L. K. Nash showing how historical cases could be effectively used in science teaching was especially stimulating.

GERALD OSBORN

THE GENERAL PRINCIPLES OF BIOLOGY, by Mary S. Gardiner, *Professor of Biology, Bryn Mawr College.* Cloth. Pages xvi+657. 16.5×24.5 cm. 1952. The Macmillan Company, New York. Price $5.25.

This is a biology text for college students and was written to be used as a text not only for those who plan to specialized in some phase of the natural sciences but also for those who need a general appreciation of biology and its contribution to man's understanding of his universe. The author prepared the book to be used as a supplementary reference to information acquired by the student in the classroom and in the laboratory, not as a text to be followed day by day.

The first section of the book is entitled, "The Organization of the Natural World." Its chapters are devoted largely to the various concepts of physics and chemistry as they apply to biology. There is also space given to consideration of ecological relationships in the firm and valid belief that a biologist needs a comprehension of the whole field and the numerous interplays as well as a comprehension of separate phases. Ecology, or scientific natural history, is gaining new stature as an important part of biological learning, and even the specialist needs this broad understanding.

The second section is called "The Organization of Biological Systems" and treats the various groups comparatively, emphasizing their unity and evolutionary development. The third section consists of a more general consideration of the operation and evolution of biological systems: reproduction, nutrition, etc. The fourth section, a single chapter, is devoted to the formalized doctrine of organic evolution—the modern concept—and its development.

This is a thorough, well integrated presentation and should be valuable for use in the many general science courses which are being added in college and university curricula.

GEORGE S. FICHTER
Oxford, Ohio

A LABORATORY COURSE IN BIOLOGY, by James C. Adell, *Chief, Bureau of Educational Research, Cleveland Public Schools;* and Louis E. Walton, *Formerly Head of the Science Department, Assistant Principal, John Hay High School, Cleveland, Ohio.* Paper. Pages vi+280. 19.5×26 cm. 1951. Ginn and Company, 72 Fifth Avenue, New York 11, New York. Price $2.20.

This is a combination laboratory guide and textbook, prepared by authors who contend that the best way of learning is by *doing*—and especially so when one of the primary messages to be conveyed is the scientific method. Because cause-and-effect relationships are stressed and the observation technique of teaching is employed, the biological facts and principles of everyday living receive greatest emphasis. This treatment, in turn, should contribute to the development of desirable social attitudes and behavior by aiding students to solve all problems objectively and through critical, scientific reasoning.

There are fourteen major units in the book each arranged as follows: (1) an explanatory text considering the topic under discussion and giving all the information needed for the experiments to follow; (2) a series of experiments based

on the text; (3) questions and statements to be filled in by the student; (4) projects to supplement the text or to be carried out individually; (5) finally, student aids consisting of questions for study, words for spelling and use, and summarizing questions. Each unit contains numerous photographs and drawings.

Other significant features of this different sort of biology text are: elimination of Latin classifications except where absolutely necessary, pronunciation of biological terms given in the text, complete glossary, suggested supplementary reading references.

A Laboratory Course in Biology is an easy-to-read text with a practical approach. It deserves strong consideration by those who wish to change their biology courses from lecture to laboratory emphasis.

GEORGE S. FICHTER

TEACHING SCIENCE TO CHILDREN, by Julian Greenlee, *Ed., D. Associate Professor of Biology and Physics, Western Michigan College of Education, Kalamazoo, Michigan.* Paper. Pages x+57. 21.5×28 cm. 1951. Wm. C. Brown Company, 915 Main Street, Dubuque, Iowa. Price $1.50.

This is not, the author admits, a syllabus of the science learnings important for little children; it is a source book of science experiences for teachers of young children, and as such, it is a valuable contribution to this all-important and often neglected field of education. The first chapter, "Understanding Children," contains an important stimulatory message for teachers, suggesting that teachers need, most of all, to recognize children as individuals rather than as stereotypes. Among the techniques suggested for teacher-improvement are: by observation of other teachers working with classroom groups, by recall of one's own experiences to acquire an understanding and sympathy for each child's problems, by becoming acquainted with the child's parents, by listening closely to a child's comments and learning how he interprets his environment, by watching the way a child performs experiments, by providing for individual participation in a flexible program, by keeping accurate records of each child to determine his development, etc. Science experiences, the author points out, are excellent opportunities for observing how a child acts and the remainder of the book is filled with the many commonplace experiences in a child's life which can be used as science teaching aids. This is a valuable aid to teachers in the elementary grades and should be made available for their examination.

GEORGE S. FICHTER

THE BATTLE FOR MENTAL HEALTH, by James Clark Moloney, M.D. Cloth. Pages x+105. 12.5×19.5 cm. 1952. The Philosophical Library, Inc., 15 East 40th Street, New York, N. Y. Price $3.50.

Here is an important book for all teachers, a book which should be made available in their libraries for study. Dr. Moloney, an eminent psychoanalyst, sets forth a grim warning regarding the rapid increase of mental illness in the United States. He tempers the warning with suggestions about restoring sound mental health to our nation.

Dr. Moloney places the lion's share of responsibility for mental illness upon current obstetrical, pediatric and child-rearing methods. He suggests a strong program of promoting relaxation in American mothers and an exchange of Cornelian Corner (rooming in) procedures for present-day maternity methods. Dr. Moloney's own theories are amply supported by scientific clinical, anthropological and experimental observations.

GEORGE S. FICHTER

DISCOVERING PHYSICS, by Harold P. Knauss, *Head of Department of Physics, University of Connecticut.* Illustrated by Harold F. Lindergreen. 443 pages. Addison-Wesley Press 1951. $6.00.

As I have said in these columns before, if we *must* have more books let them be better ones. Of the making of books there seems to be no end, but unfortunately only mediocrity or less is achieved by far too many. Library stacks are loaded with tens of thousands lying innocuously to gather dust; professors' and teachers' shelves are stacked high with texts which neither the professor nor the student has looked at twice! This book by Professor Knauss will not, I am sure, have such a career.

The text is designed for secondary schools but it seems highly appropriate for certain college quarters where the formal rigorous physics course does not fit. I am of the opinion that *every college student* should now have a course in physics (not these watered-down survey courses which cover the universe and other things!) and this text would admirably fit the humanities, for example, and the social studies students. These people are now living in a *physics world*. They say they want to know our physics but that we put it out of their reach. This book puts it within their reach, in a creditable fashion.

The subject matter is fairly standard but the treatment is invitingly new. The exposition is discursive and reads easily; it sounds like dialogue, which intrinsically possesses instructive temper.

The format is highly attractive; the pages are about 7" by 9½" with margins (outer) 2" or so. These margins bear line drawings elegantly done and well captioned. The "symbolic" illustrations, leading the chapters and elsewhere in the text, are handsomely executed, stirring, and imaginative. Good photographs are appropriately dispersed throughout the book.

The physics *appears* unassailably sound although only a *user* of a text can properly discover this. One reading by a reviewer can never accomplish it. I am sensibly certain, however, that this text contains no glaring inadvertencies.

A collection of Exercises and Problems based on the chapters is provided, as is a Glossary.

High school physics teachers should look into this book at once, and college physics people should recommend it to the humanities. I predict a good future for this text, which it highly deserves.

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An Introduction to Acoustics, by Robert H. Randall, *Associate Professor of Physics*, The City College of New York. Pages xii+340. Addison-Wesley Press. 1951. $6.00.

This textbook on acoustics is designed to bridge the gap between the elementary and the specialized graduate-level treatment. It pre-supposes a minimum of one year of college physics and a year of the calculus, but a competence in partial differential equations strikes me as a more appropriate background.

Like all branches of our knowledge the developments in acoustics in recent years have been astonishing, and new worlds have been opened up. The major paths of inquiry have been the reproduction of speech and music, and the signaling demands of war. The subject embraces two fundamental aspects of all physical phenomena—*vibrations and waves*—and on this count its study is of unbounded importance to all physics and engineering. The physicist and engineer, therefore, acquires a very useful tool by the study of acoustics.

The text is smoothly written and possesses mathematical rigor. The theory is well put up. Although not an exhaustive treatise it embraces a goodly measure of modern acoustical knowledge—theoretical and applied. A *good* class with adequate background mathematically, under the direction of an able teacher, would have a very enjoyable semester with this text.

The problems are very good. Selected references are given.

Professors giving a semester course in this quarter would do well to try this text. High school teachers would profit immeasurably by just reading the book.

Julius Sumner Miller

ADVANCED FLUID DYNAMICS AND FLUID MACHINERY, by R. C. Binder, Ph.D. *Professor of Mechanical Engineering, Purdue University*. 426 pages. Prentice-Hall 1951. $6.00.

This book is an extension of the author's *Fluid Mechanics*. Part I covers one-dimentional compressible flow, flow with friction and heat transfer, and boundary layer flow. Part II gives information about common machines in practice. Part III is engineering fluid dynamics.

The book is an outgrowth of course work and mimeographed notes presented at Purdue over a period of years. The material has, therefore, been tested in the classroom.

The exposition is clear; the diagrams very well done. There are some excellent shadow photographs. The problems and references are very good. There is sensible balance between engineering complexion and the purely analytical (theoretical), so that the book should have wide applicability in both quarters.

JULIUS SUMNER MILLER

CHEMISTRY IN ACTION, Second Edition, by George Rawlins, *Professor of Chemistry, Austin Peay State College, Clarkesville, Tennessee* and Alden H. Struble, *Teacher of Science, Western High School, Washington, D. C.* Cloth. Pages 575. 23.5×16.5 cm. 1952. D. C. Heath and Company, Boston 16, Massachusetts. Price $3.60.

The stated purposes of the authors, "to help you understand and appreciate the role of chemistry in your lives and to help you learn to reason scientifically," seem to have been kept in mind during the preparation of the book. Examples are drawn from experiences that should have the intended meaning to persons for whom the book is written. Each unit is preceded by a stimulating preview in which the authors give the prospective reader some idea as to what the unit contains and the reason for including the particular content.

Unit headings are: Chemistry and Our Material World, A Chemical View of Matter, The Structure of Matter, Theory of Solutions, Nitrogen and Its Compounds, The Wonder Element Carbon, The Periodic Law and Chemical Families, Some Important Nonmetals, and The Metals. Units are divided into a number of areas, each of which is introduced by a question. Subdivisions of these areas are also generally introduced by stimulating questions.

Teachers will like this well organized teachable text. They will appreciate the generally well chosen review problems and questions. The glossary of terms and the bibliography both of books and films should prove useful.

JULIAN GREENLEE
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FUNDAMENTALS OF ATOMIC PHYSICS, by Saul Dushman, Ph.D., *Research Consultant, Formerly Assistant Director, Research Laboratory, General Electric Company, Schenectady, New York*. Cloth. Pages x+294. 15×23 cm. 1951. McGraw-Hill Book Company, 330 West 42nd Street, New York 18, N. Y. Price $5.50.

"There is no longer warrant for separate departments of Chemistry and Physics," said Dr. Irving Langmuir at an American Chemical Society meeting some years ago. This book is confirming that pronouncement. Fifty years ago the title "Atomic Physics" would have been dubbed "a pair of mis-mated words." Not so today.

The author, in the preface, accounts for the development of this book. He, and others, were called upon to "enlarge the grasp of newer developments in the physical sciences" for a group of high school science teachers in attendance at Union College, Schenectady, N. Y. This volume grew from content set up for those teachers.

There are fourteen chapters, only five of which are specifically addressed to the atom. The first eight are what might be called preparatory refreshers on

fundamentals of theoretical physics for later use in the "physics of the atom." Included in these first eight are: "A Brief History of Physics" and "A Mathematical Introduction." The ninth chapter is concerned with the Bohr Theory of the atom's structure, and the tenth treats atomic structure as related to the periodic arrangement; chapter twelve is on Isotopes and the thirteenth deals with nuclear phenomena. These last chapters are supplemented by one on "Matter Waves" and the final one on "High Velocity Generators for Particles."

It is anticipated that the reader of this volume will have a working knowledge of calculus even though chapter two gives a review of the mathematics used in the body of the book. However, one can get much from most chapters even if the mathematical parts are more involved than he can follow. Diagrams and graphs are used in generous fashion and with tables and appendices provide the student or reader with "tools for understanding." An eight page double columned index likewise contributes to that end.

B. Clifford Hendricks
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A DRAMATIC DISTINCTION BETWEEN PRESSURE AND FORCE

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It is often difficult for beginners to grasp the fundamental difference between pressure and force as used in the strictly technical sense and indeed, the terms are much abused and ill-used by those who know better. It is very easy to say 'pressure' when one means 'force', and conversely. The terms are invariably used in a totally wrong sense by people at large. To aid the student then, in grasping the very essential distinction I use a little discussion which possesses dramatic complexion. This is it:

Consider a cubical box, water-tight, 10 cm. on an edge, fitted in its top with a "chimney" of square cross section, 1 cm. on an edge and 10 cm. tall. The volume of the box is 1000 cm.^{3} and the volume of the chimney 10 cm.^{3}. (Draw the box with the chimney.)

1. Let us fill *the box only* with water. The weight of the water in the box is 1000 grams. This is supported by the bottom of the box of area 100 cm.^{2}, and thus the *pressure* at (on) the bottom of the box is 10 gm/cm.^{2}. The *force* on the bottom of the box is, as already said in other language, 1000 grams. Recapitulation: *force* 1000 grams; *pressure* 10 gm/cm.^{2}.

2. Let us now fill the chimney. This requires 10 cm.^{3} of water or 10 grams of water.

How do things *now stand* with regard to the bottom of the box?

(a) We have added only 10 grams of water.

(b) Since pressure is a linear function of the depth (other things being equal), and the depth of the water above the bottom is

now 20 cm., the pressure there is 20 grams/cm.^{2}. We have doubled the depth of water and thus doubled the pressure.

(c) The area of the bottom is still 100 cm.^{2}. The *pressure* is 20 gm/cm.^{2}. The *force* on the bottom of the box is clearly 2000 grams.

We have, therefore, produced an additional force of 1000 grams on the bottom of the box by simply adding 10 grams of water!

I am indebted to my colleague, Dr. Harold W. Lucien, for putting the following query: *How could you now show experimentally that this new force is 2000 grams?* It can be simply done. JSM.

PLASTIC HEAD AIDS MEDICAL RADIATION THERAPY

An anatomical model of the human head, of natural size and made of translucent plastic, was demonstrated here to the Radiological Society of America as the latest aid to the study of X-ray treatment of cancer.

Developed at Bellevue Hospital, New York, and constructed and cast by Bakelite Company at its laboratory at Bloomfield, N. J., it is designed as an aid to doctors and medical students in the latest techniques of radiation therapy. It is used to demonstrate how to beam X-rays at internal areas where cancerous growth is most prevalent.

The conception and designing of the head was by Dr. Rieva Rosh, New York University College of Medicine, and Dr. Oscar H. Cohen of Bellevue Hospital. Bakelite resins were chosen to mold the translucent model because of their dimensional stability, light weight, high refractive index and resistance to impacts, heat and light.

The model is mounted on a revolving base. It is cast in two halves so that internal anatomy can be revealed. Within the Plastic head are imbedded battery-operated light bulbs that illuminate principal areas affected by tumors. The aiming of beams of radiation with the necessary pin-point accuracy at the affected area within a human head is made easier by the new model.

A CO-ED IN A NEW FIELD

A University of Wisconsin co-ed is the first woman to take a U.W. doctor's degree in zoology and wildlife management because she wants to explain her furred and feathered friends to as large an audience as possible.

She is Ruth Hine of Springfield, Mass., whose approach to the mouse is by way of the trap and the scalpel rather than the shriek and the leap to the mantel.

She is now attached to the wildlife research section of the Wisconsin Conservation department's game management division, doing technical and popular writing as well as research in the woods and fields.

"As early as I can remember I treasured grubby little collections of bugs, birds' nests, and small animals," she admits.

Ruth does autopsies on field mice with the dispassionate interest other women take in knitting an Argyle sock or baking an apple pie. Her idea of a profitable Sunday afternoon is one spent prying open the mouths of dead deer to study their back teeth.

She took her undergraduate work in zoology at Connecticut College for Women and then came to Wisconsin to take her master's and doctor's degrees.

For her doctoral thesis, she did a study of small mammals of the Madison area to trace the ups and downs of the population during the four seasons and in various environments.